

I'LL SAVE MY BRAIN

A doctor's mission to treat his own tumour

NewScientist

WEEKLY January 10 - 16, 2015

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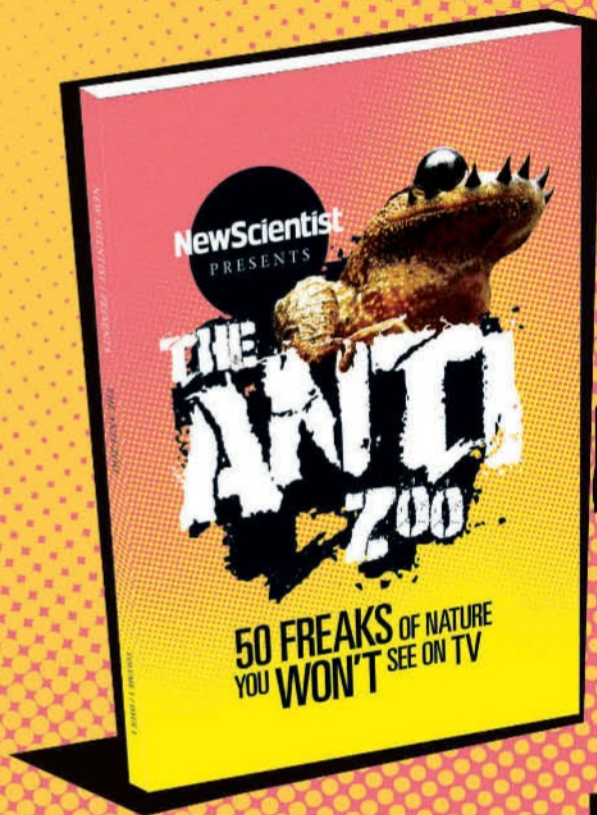
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Microelectronics : the next 20 years

This elastic market is illustrated by the case for computers in the home. On the one hand are the disbelievers who state that there is only a small range of operations for which the householder will ever need a computer — estimating his taxes once a year, paying bills and balancing budgets once a month and very little else. On the other hand are the optimists who argue that if **microelectronics can make small computers as inexpensive as telephones then people will buy them, even though they are in use for a small fraction of the time. Once in the house, or small office, new uses will be found for them and eventually they will affect life to an even greater extent than the TV set has.** If the optimists are right then the market is huge. Other markets which are waiting to be opened up are ground and air traffic control, process control of all sorts, medical as well as industrial, and on-line reservation systems. Whether or not microelectronics has this particular future depends on improvements in what we already have today — not on new materials, new

New Scientist, 16 March 1972



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NASA/ESA/HUBBLE COLLABORATION (STSC/AURA)



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ROD WILLIAMS/NATUREPL.COM



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STEVE PARSONS/REUTERS

Inform, educate, cure

It's time to take patient participation in drug research seriously

2014 was a landmark year for drug development. The US Food and Drug Administration approved 41 new pharmaceuticals, the most since 1996. Each of these will (hopefully) make the world a slightly better place, alleviating distress and preventing premature deaths.

But developing drugs is excruciatingly expensive – and increasingly so. The cost of bringing a new compound to the market is now around \$2.5 billion, twice as much in real terms as it was a decade ago.

One of the costliest parts is recruiting and retaining volunteers to test the drug in a clinical trial. Around three-quarters of trials are delayed

by problems with this process. Most trials over-recruit by up to 50 per cent to compensate, but the drop-out rate is still so high that only 1 in 20 volunteers end up generating useful data. The result: wasted time, effort and money.

That is not for lack of patient willingness. In 2013, the UK's House of Commons found that people want to volunteer but don't know how. Only about 7 per cent of people with cancer who are eligible to participate in a trial do so, for example.

It doesn't have to be that way. There is evidence that volunteers can be brought on board and kept there by making more of an effort to inform them and help them to choose which

trial they would like to enter.

On page 10, we report how such knowledge can be empowering. Former doctor Stuart Farrimond is weighing up experimental treatment options for his brain tumour – to his benefit and that of the companies behind the treatments. He is unusually well-informed, but his story hints at what an empowered, informed patient group might look like.

The problems with volunteer recruitment were identified a decade ago but haven't been eradicated. It is high time they were. Drug development costs – and delays – are ultimately passed onto the consumer. It is in everyone's interests to get rid of this unnecessary waste. ■

A design for life

EAT clay, drink urine, go vegan until 6 pm then eat what you like. For people trying to lose weight or eat more healthily, there is always a new fad diet on the table – often with a celebrity endorsement.

In the unlikely event that you're tempted, beware. These particular ones are among the British Dietetic Association's "top 5 worst celebrity diets to avoid in 2015".

The list is slightly tongue-in-cheek, but it carries a serious message. Although fad diets can sound plausible, there is usually little evidence that they work and a risk that they could be harmful. A year ago, the BDA was warning about biotyping and gluten-free diets. New year, same old story.

There is, of course, a proven method to lose weight, but it lacks novelty and celebrity backing. In a

nutshell: eat less and move more.

If that sounds too tedious, there is another way. It is becoming increasingly clear that your environment – from the crockery and drinking vessels you use to where you sit in restaurants – influences your eating habits. Adjusting these factors might sound almost as faddish as eating clay, but it is backed by mounting evidence (see page 36). It is also easier to maintain than a fad diet. So not all crazy-sounding diets are nonsense. But do read the label. ■

Did AirAsia flight stall?

A STALL may be behind it all. That's the indication from radar data recorded during the final moments of Indonesia AirAsia flight QZ8501, which crashed into the Java Sea on 28 December, killing 162 people.

In the pilots' last communication before losing contact with air traffic control, they requested permission to climb to avoid bad weather on their way from Surabaya, Indonesia, to Singapore. According to data leaked on Twitter by aviation analyst Gerry Soejatman, the plane seems to have been at an altitude of 11,000 metres and climbing at 654 kilometres an hour shortly before it crashed. This suggests that QZ8501 was far below its typical cruising speed - by comparison, a nearby Emirates flight was travelling

level at 932 kilometres an hour at almost the same altitude.

Further radar data tweeted by Soejatman appears to show QZ8501 falling out of the sky, losing 3300 metres of altitude per minute. If accurate, the information suggests that the pilots may have climbed too quickly, lost airspeed and stalled in the thin, high-altitude air before plummeting into the sea.

Confirmation will have to wait until recovery crews are able to locate the plane's "black box" data and cockpit voice recorders, which are thought to be resting on the sea floor. Wreckage and many of the bodies of passengers have already been found, but bad weather and high waves have slowed efforts to locate and retrieve the black box recorders.



Still looking for the black box

Testing Ebola

DESPERATE times call for desperate measures. A British nurse, Pauline Cafferkey, remained in critical condition as we went to press this week, after contracting Ebola in Sierra Leone. She is being treated with plasma from a former Ebola patient, which is packed with antibodies to the

"Because control efforts in Monrovia are working, it might be hard to find 140 patients for the drug trial"

virus, and an unidentified experimental drug.

She is a high-profile case, but by no means the only person being treated with candidate drugs: trials of two experimental drugs have now started among Ebola patients in Liberia and Guinea, and the third will start being organised in Sierra Leone next week. This will involve the first-ever RNA-based drug to be tested against an infection in humans.

The drug, made by Canadian firm Tekmira, is a "short interfering" RNA (siRNA),

designed to stop a key virus gene from working. With US military funding, Tekmira has developed stable nanoparticles of fats and siRNA that stop the Ebola virus from replicating by blocking a specific gene. Intravenous doses starting half an hour after infection saved monkeys from lethal infections.

Tekmira announced on 22 December that it would carry out human trials in West Africa with siRNA specifically matched to the epidemic strain.

Peter Horby of the University of Oxford is leading the Liberia trial of a conventional antiviral, brincidofovir. That began on 1 January in Monrovia, previously a hotspot for the epidemic. Now, though, control efforts in the city are working, and it might be hard to find the 140 patients needed.

"This is good news, but we also have to move fast to test these drugs," says Horby. He is helping set up the Tekmira trial and will look out for further test sites in Sierra Leone. They will still be needed: despite improvements in some areas the epidemic shows no sign of stopping.

New antibiotics

IT'S time to strike back. Antibiotic resistance has garnered headlines in recent years, but 2015 may be the year we overcome it.

Two new antibiotics were announced this week. One, teixobactin, was discovered by screening soil for bacteria that have evolved to kill their competitors. It appears to act on MRSA and the bacteria that cause multi-drug resistant TB, among others, by targeting a lipid on their cell walls.

Most existing antibiotics target bacterial proteins but these alter over time, leading to resistance. The team developing the drug at Northeastern University in Boston reckons that if it was used to treat people, it would take at least 30 years for bacteria to develop resistance (*Nature*, doi.org/x3m).

The second drug is being developed by Novartis to treat multi-drug resistant TB (*Science Translational Medicine*, DOI: 10.1126/scitranslmed.3010597). Both drugs worked in mice and trials are planned for teixobactin.

How much oil must stay buried?

WE MUST stop burning coal in just 15 years' time, and oil in 25, unless we find a way to bury carbon. That's according to Christophe McGlade and Paul Ekins at University College London, who have calculated how much fossil carbon needs to stay underground for a reasonable chance of avoiding dangerous climate change.

They call it "unburnable carbon", and say the most economical method is to keep a whopping 88 per cent of global coal reserves buried, most of it

in the US, China, India and former states of the Soviet Union (*Nature*, DOI: 10.1038/nature14016).

"What we are really talking about here is unemittable carbon," says Myles Allen of the University of Oxford. "If the fossil fuel industry can crack the problem of extracting energy without dumping carbon dioxide in the atmosphere, then we will be able to use as much fossil carbon as we like." That means using carbon capture and storage.

Save the monarch

WHAT is black, orange, stripy and at risk of extinction? The monarch butterfly. Last week the US government agreed to assess the butterfly for inclusion on its endangered species list.

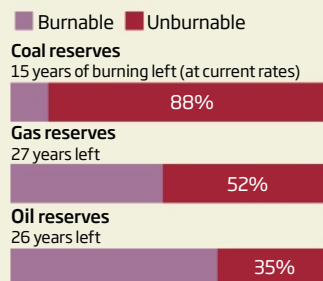
"Monarchs are being hit hard from all directions, especially from loss of breeding habitat"

Best known for massive migrations between Mexico, the US and Canada, the butterflies had dwindled to 35 million by last winter, according to the Arizona-based Center for Biological Diversity. That's a drop of 90 per cent in 20 years.

"Monarchs are being hit hard from all directions," says Ernest Williams, who studies monarchs at Hunter College in New York. He cites climate change and the loss of breeding and winter habitats as the main factors behind the decline. "Many monarch biologists think that the loss of breeding habitat currently has the strongest effect," he says. The herbicide Roundup may be the main culprit. It kills milkweed, the monarch caterpillar's only source of food.

"The monarch certainly warrants listing," says Tierra Curry of the Center for Biological Diversity. But due to a backlog of species the monarch could end up on a waiting list, she says.

Vast amounts of fossil fuels will have to stay in the ground if we are to avoid 2°C of warming



NASA, ESA AND THE HUBBLE HERITAGE TEAM (STC/AURA)



More starry in the infrared (left)

Hubble double

HUBBLE is reprising one of its greatest hits. The space telescope – which turns 25 this year – has captured two dramatically sharper views of the Eagle nebula's "Pillars of Creation".

Back in 1995, Hubble's Wide Field and Planetary Camera 2 took an iconic photograph of the nebula, revealing three towering "elephant trunks" of gas and dust that are in the process of forming stars. The columns are also being

"Having images taken 20 years apart helps astronomers gauge how the nebula is changing"

sculpted and eroded by winds from nearby young stars.

Now Paul Scowen at Arizona State University in Tempe, one of the astronomers responsible for that image, and his colleagues have taken a fresh look at the nebula. They made use of Hubble's Wide Field Camera 3, installed in 2009, which has twice the resolution of the earlier camera. It shows that the gas and dust at the pillars' edges become denser more abruptly than thought (above right).

The team also photographed the region at infrared wavelengths (above left), revealing infant stars inside the gas and dust. That

should help astronomers work out whether the nebula is an efficient star-former.

Having images taken 20 years apart also helps us gauge how the pillars are changing. Scowen, who presented the work this week at the American Astronomical Society meeting in Seattle, Washington, says jets of gas have visibly moved in the interim.

Proof positive (not)

IF NOBODY understands a mathematical proof, does it count? Shinichi Mochizuki of Kyoto University, Japan, has tried to prove the ABC conjecture, a long-standing pure maths problem, but now complains that fellow mathematicians are failing to get to grips with his work.

Mochizuki's 500-page paper, posted online in 2012, is extremely difficult to follow, even for mathematicians. In a new report he says that three researchers who studied it with his help have yet to find an error, but it will take a few more years for it to be fully confirmed. Some of his colleagues say Mochizuki could help things along by simplifying his notes or lecturing abroad.

Minhyong Kim of the University of Oxford sympathises with both positions. But for now, the proof stays in limbo. "It's a curious state," he says.

60 SECONDS

Blaze in Oz

Australia has been hit by the worst bush fires in 30 years. Temperatures soared to 44.1°C in parts of South Australia on 2 January, igniting fires across the state. The flames had claimed 38 houses and scorched more than 12,500 hectares at the time of going to press.

It ain't half hot

Last year was the hottest on record in the UK, according to the Met Office. The average temperature was 9.9°C. That is 1.1°C above the long-term average and higher than the previous record of 9.7°C set in 2006.

Rice fit to eat

For the first time since the 2011 nuclear disaster in Japan's Fukushima prefecture, the region's rice has passed radiation tests. Almost an entire year's harvest, 360,000 tonnes, has been checked and none of it exceeded 100 becquerels per kilogram, the limit set by the government.

Lie still

Bad news, compulsive fidgets: your restlessness may be your undoing. Researchers will present an alternative to the polygraph lie detector at a conference in Hawaii this week. It's a full-body suit that captures tiny movements, designed to pick up liars' tendency to fidget nervously. In tests, the suit correctly identified liars 82 per cent of the time. A polygraph has a typical success rate of 60 per cent.

Philae meet rover

It seems that comet-landing fever is catching even at the highest levels of government. The French president François Hollande has named his new dog Philae, after the European Space Agency probe that touched down on comet 67P/Churyumov-Gerasimenko last year. Meanwhile, ESA is still hunting for the real Philae, which is nestled near a rock somewhere on the comet's surface.

Brave new world-hunters

Exoplanet telescopes are slimming down to collect alien worlds

Rebecca Boyle

A NEW search for our nearest cosmic neighbours is just beginning. Under construction now on an Arizona mountaintop, the Minerva observatory will look for small worlds around bright, nearby stars. By using off-the-shelf equipment, rather than bespoke scopes, Minerva – the Miniature Exoplanet Radial Velocity Array – offers a novel and cheap way to hunt for our solar system's closest companions.

Exoplanet science has exploded since the first discovery of a world outside the solar system in 1995. More recently, between 2009 and 2013, NASA's Kepler space telescope raked in thousands of probable worlds. But most such planets have been spotted from space or with giant telescopes on remote mountaintops, which cost millions of dollars and require repeated observations over several years to confirm sightings.

By contrast, Minerva and a collection of other small observatories use relatively

simple off-the-shelf telescopes. That makes this planet-hunting vanguard wholly unlike marquee observatories such as the W. M. Keck Observatory in Hawaii and the Kepler telescope – and that is precisely its advantage.

"We're looking at a small number of bright stars every night, all the time, for years. That's normally very hard," says Jason

"Minerva is the latest in a growing succession of amateur telescopes used for very big science"

Wright, Minerva's co-investigator and an astronomer at Penn State University. "Because we've designed this observatory and it's ours, there's no one to compete with."

Minerva uses four 0.7-metre-wide, 2.5-metre-tall commercial telescopes built by a company called PlaneWave, which also sells them to hobbyists for about \$200,000 – Amazon founder Jeff Bezos bought one just before Minerva's team. The light from all four scopes is collected and fed

into a spectrograph, which splits it into different wavelengths and enables astronomers to see tiny variations in a given star's movement with respect to Earth. Such variations show something orbiting the star is exerting a faint gravitational tug on it and lets astronomers determine the orbiting object's mass.

Minerva will also be able to watch stars for brief dips in brightness that indicate something crossing in front of them. Seeing a regular pattern of dips reveals an orbiting object, such as a planet. This technique, called the transit method, is Kepler's strategy, and allows astronomers to calculate the planet's size. Combining size and mass gives the planet's density – a clue to its composition.

But both methods take time, especially for small worlds orbiting close to their stars, which Minerva will focus on.

"As we get toward truly Earth-like planets and truly Earth-like orbits, it's a very tough detection problem," says Greg Laughlin, an astronomer at the University of California at Santa Cruz who uses another dedicated planet-hunter, the Automated Planet Finder.

When Minerva's lead scientist, astronomer John Johnson of the Harvard-Smithsonian Center for Astrophysics in Massachusetts, designed the observatory, he wasn't aiming for speedy science. As a graduate student at Lick Observatory in southern California, he used a neglected older telescope to hunt for planets over a long stretch of time, choosing patience over precision and observing power.

"If you have high precision, more people want it. If it has crappy precision, it's probably on an old telescope nobody cares

NASA, ESA, AND THE HUBBLE HERITAGE TEAM (STSC/AURA/ESA/HUBBLE COLLABORATION)



Half of Minerva's gear

about," he says. "Typically, the more time you have, the less precision. Minerva is the first facility to have very high precision, and lots and lots of time. It's an unexplored territory."

Off the shelf

In other respects, Minerva is not so unique. It's the latest in a succession of amateur telescopes used for very big science. Gamma-

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Pick your targets wisely

ray astronomers already use such networks to scrutinise distant galactic explosions, for instance. Minerva will be able to do that, as well as observe asteroids crossing in front of stars, Wright says.

Funding has been one major motivation to try off-the-shelf tech, says Dave Charbonneau, also at the Harvard-Smithsonian Center, who was one of the first to build a planet-hunting system using commercially available

telescopes. His MEarth project has been searching for small planets orbiting red dwarf stars since 2008 and has notched one discovery so far. "If you associate cost with a telescope – like one night of Keck time, or a few hours of Hubble time – that same cost

"This is no longer the day of swashbuckling scientists trying to get as many kills as possible"

would allow you to buy your own observatory," he says.

Astronomer Gáspár Bakos at Princeton University has been remotely operating the HATNet (Hungarian-made Automated Telescope Network) project for 10 years, and has published findings on 56 planets.

The six HATNet telescopes are each just 10 centimetres wide, but they function as a network. A companion project, HATSouth, has 24 telescopes spread across Chile, Namibia and Australia. This provides unprecedented coverage for transit searches, Bakos says. "The planets don't honour the rotation of Earth, they transit at their leisure. With a network, you catch all the transits."

Strategic search

Meanwhile Laughlin's custom-designed Automated Planet Finder has been hunting planets from a mountaintop in California since last January. It has already bagged two exoplanet systems. Its most promising finds will be candidates for follow-up searches with telescopes like the Transiting Exoplanet Survey Satellite (TESS), set to launch in August 2017.

"We have an opportunity to probe these charismatic nearby stars," Laughlin says. "Without that ultra-high, dollar-per-second Keck pressure on you, you can look at things that you otherwise might be scared to."

Since Kepler's staggering number of finds implied most stars probably have planets, astronomers are increasingly aiming for detailed planet studies instead of just making discoveries, Johnson says.

"This is no longer the day of swashbuckling scientists trying to get as many kills as possible," he says. "There is so much great science just sitting on the floor... with the Kepler statistics in hand, we're no longer in the area of planet hunting. We're in the era of planet gathering."

That means searching a smaller

EYES PEELED

As the hunt for exoplanets intensifies (see main story), astronomers are dreaming up increasingly strange alien worlds. The latest is a "double-eyeball" planet, an icy orb with a central sea of liquid water on each side.

These planets are expected to be rocky worlds orbiting a red dwarf star. A red dwarf's habitable zone – the region warm enough for liquid water to exist – is so close to the star that a planet orbiting there is likely to have its rotation locked due to orbital resonance. That means the same side of the planet always faces the star, similar to how we only see one side of the moon from Earth.

Previous research suggests that water on such a planet would remain liquid only in the centre of the side facing the star, resembling a pupil surrounded by an icy eyeball.

Now Anthony Dobrovolskis of the NASA Ames Research Center in California says worlds with an oval orbit – rather than circular – could make a double-eyeball. This orbit changes the resonance so that different sides of the planet face the star on successive close passes, forming two central seas facing in opposite directions.

This beady-eyed world would be bad news for life. A build-up of ice at the poles or other cold spots could shift its rotation axis and tilt the entire world, says Dobrovolskis. If there was any life on the planet, this would be likely to cause mass extinctions (*Icarus*, doi.org/x2c).

field more strategically, he says. Rather than staring at 100,000 stars like Kepler, Minerva will watch just 164 nearby targets, focusing on the ones most likely to yield interesting worlds.

"We're just driven by the idea that those planets are right next door. We want to chart our neighbourhood," Johnson says. "You can find these little gems when you're really targeting your search." ■

My brain tumour, my options

Former doctor **Stuart Farrimond** assesses the radical treatments that could stop his cancer

ONE day, perhaps in the next five years, I will develop a malignant brain tumour called a glioblastoma that could take just 15 months to kill me.

As a former practising doctor, I know that these tumours are some of the hardest to treat – which is why this short prognosis has remained largely unchanged for the last decade.

But radical thinking is starting to yield results. For example, an innovative “anti-cancer hat” has been so successful that trials have been cut short to allow more people to benefit from this approach as quickly as possible. Other unconventional treatments are also moving forward in trials.

My medical career ended the day I was diagnosed with a glioma brain tumour, back in 2008. While it was surgically removed several days later, the cancerous growth had already seeded my brain with microscopic deposits, which will help it to return as an angrier and more aggressive glioblastoma. In

2008, I was given a 50 per cent chance of making it to 2020, but who knows – one of these new options could help me live longer.

Nanotherapy

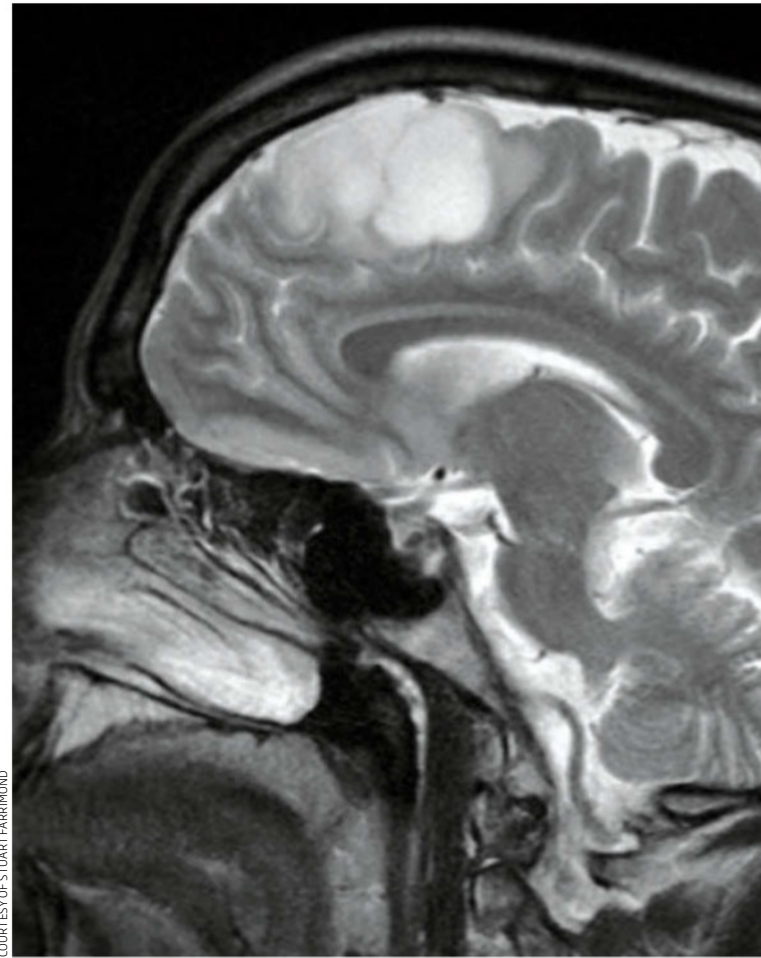
When a tumour is buried deep within the brain, removing it risks causing brain damage. Nanotechnology offers a safer alternative. A technique dubbed Nanotherm involves injecting tiny metallic spheres – just 12 nanometres across – into tumours. When agitated using a strong alternating magnetic field, these spheres heat up to 80°C – enough to cook and cauterise a tumour from the inside.

Created by a team at German firm MagForce, this approach is being tested as a method to boost the power of chemotherapy and radiotherapy for treating glioblastoma brain tumours. Early trials have been a success, and MagForce’s Hoda Tawfik says that some recipients have lived for nine years after diagnosis. Larger trials are now under way to find out just what part Nanotherm can play alongside existing treatments.

A potential cure for me? Tawfik hedges her bets, explaining that this treatment will work best alongside others. “We do not have a cure,” she says, but adds that their work so far can “offer hope of long-term survival”.

Anti-cancer hat

In November, Roger Stupp at the University of Zurich in Switzerland proclaimed the



COURTESY OF STUART FARRIMOND

birth of “a new standard of care for patients suffering from glioblastoma”. Speaking in Miami, he was describing an anti-cancer hat, or the NovoTTF-100A to give it its official name.

Twenty years in development, the NovoTTF-100A doesn’t have the pipes and metalwork I would expect from a cancer-killing machine. It’s more like the sort of thing Apple would design – a white skull cap attached to a battery pack (see photo, top right).

It is designed for people with glioblastoma to wear for 18 hours a day, while military-grade ceramic transducers within the hat pulse alternating electrical fields into the brain. These fields interfere with the protein framework that’s essential for cell division, preventing the replication of malignant tumour

cells, which divide far more often than healthy adult cells.

An ongoing trial of 315 people receiving chemotherapy while wearing the device has found that they are 50 per cent more likely to be alive two years after diagnosis than those receiving standard treatments. These mid-trial results were so impressive that the test is due to end early so that more people can use the device as soon as possible.

David Stocker, from the device’s manufacturer Novocure Europe, says the hat has been too much like science fiction for some, who believe the use of electric fields in medicine has more to do with quackery than science. “Many researchers and academics have a hard time understanding how the system works,” he says. “It is only now that we have the trial results



JAMES GREEN

A personal interest



Stuart's glioma tumour was discovered in his frontal lobe during a routine scan in 2008

to show beyond any doubt that it does actually work."

The NovoTTF-100A is no silver bullet though – it usually only adds months to life, effectively slowing but not killing the cancer, although some users have gone on to live for more than 10 years. I would be interested to know if it could be used for people like me, whose tumours have not yet progressed to a highly aggressive glioblastoma. And while the idea of killing cancer while I shop is appealing, the eye-watering cost of £17,000 a month is less so.

Personalised vaccine

A cheaper alternative might be a personalised vaccine called DCVax. Developed by NorthWest Biotherapeutics in Bethesda, Maryland, this approach uses

a person's own immune system to attack their cancer.

Cancer vaccines have been tried before, but virtually all have failed. Linda Powers of NorthWest Biotherapeutics says most existing attempts are "trying to rehabilitate immune cells that have already been hobbled by the cancer". Her firm's solution is to rekindle a person's exhausted immune system by growing new white blood cells for them.

The idea is that bone marrow cells that haven't yet matured into immune cells are extracted from a person's blood and nurtured in the lab into dendritic cells – the army generals that organise the rest of the brain's immune system. Exposing these cells to biomarkers from the person's tumour primes them to seek and destroy that particular cancer.

The finished batch of activated, educated immune cells are then injected into the person's blood to do their work.

And it is so far so good in early trials. One trial had an average survival of around three years, and in some tests, a few individuals have gone on to survive more than 10 years – that's eight times the average of 15 months.

Applying this technique to an earlier stage glioma like mine might perhaps prevent it from mutating into a glioblastoma. And because it would be my immune system doing the work, there are likely to be relatively few side effects. For now I'm crossing my fingers – randomised trials for people with glioblastoma are now recruiting with early results expected later this year.

Gene therapy

Meanwhile, Dror Harats of Israel-based VBL Therapeutics thinks he may have devised a gene therapy technique that could change my future. His strategy hits cancer cells' ability to divide by targeting their blood supply and starving them of the fuel they need.

As a tumour grows, it releases chemical messengers that trigger new blood vessels to grow toward it, feeding its voracious appetite for oxygen and nutrients. Through 20 years of research, Harats discovered that the cells lining these newly forming capillaries have unique genetic features that can be exploited. His team has genetically engineered harmless adenoviruses to infect

"I would snatch anyone's hand off to get a nanoparticle injection instead of an operation"

the capillaries' cells and insert a gene that triggers them to self-destruct.

In early human trials, this experimental treatment, called VB-111, has fared remarkably well, apart from some flu-like



Too sci-fi for some

symptoms. When tested on 46 people with glioblastoma for whom all other treatments had failed, those who received repeated injections of virus particles alongside standard drugs survived for 18 months – much higher than the average life expectancy for such patients, of around six months.

If these numbers hold up under repeated testing then VB-111 will be a landmark breakthrough, offering a longer, better quality of life. It wouldn't work for me yet, but could be an option once my tumour becomes a glioblastoma. But speaking personally and not as a doctor, I confess I have some irrational hang-ups about a genetically engineered virus coursing through my blood.

Eyeing my options

As a doctor, I am encouraged that these treatments offer serious potential – and as a patient, I'm excited by what they could offer me. I would snatch anyone's hand off to get a nanoparticle injection instead of an operation, and the anti-cancer hat could well treat my tumour while I live a normal life, walking the dog or doing the shopping. Although none would count as a cure, each of these treatments boasts a handful of long-term survivors, and over the next five to 10 years, it is possible that combined therapies could turn this terminal condition into a controllable one. ■

Virtual reality puts jury in crime scene

Jessica Hamzelou

GUILTY or innocent? To help them decide, judges and juries are often presented with reams of evidence: crime scene photos, medical documents or suspected bullet trajectories – all on paper. But could allowing people to watch the crime unfold from the comfort of the courtroom lead to more informed judgments?

This may soon be possible, thanks to the virtual reality headset Oculus Rift. “Imagine you could transport the entire jury, the judge, the litigators – everybody – back to the crime scene during the crime,” says Jeremy Bailenson of the Virtual Human Interaction Lab at Stanford University in California. “That would be the best thing possible for any trial.”

Over the last few years, investigators have begun to use sophisticated technology to capture 3D information about a crime scene. This can range from using MRI and CT scanners to get a detailed picture of people's injuries to using lasers to map the entire scene.

However, when the case gets

to court, a lot gets disregarded. “We have detailed measurements and all this 3D information, but then we hand it over on paper, and that comes with a loss of information,” says Lars Ebert at the Institute of Forensic Medicine in Zurich, Switzerland.

In some cases, 3D information is vital. Take gun crime. Conventionally, bullet trajectories

are presented on paper. “What you have is a line on paper, and it's difficult to get an idea of how it moved in space,” says Ebert. “But the second you see it in 3D, you know where it originated, where it goes, how close all the people and objects are.”

To allow evidence to be assessed in 3D, Ebert and his colleagues turned to Oculus Rift, a headset used by gamers to provide an immersive environment. The team entered all the information the police had about a particular shooting into software for the device. This allowed them to create a 3D reconstruction of the

crime, complete with bullet trajectory (*Forensic Science, Medicine and Pathology*, doi.org/x2s). The team call their system the “forensic holodeck” after the *Star Trek* simulated reality device.

When Ebert presented the reconstruction of the gun crime to police officers present at the scene, they were impressed. “They said: ‘wow, that was exactly what it was like when I was standing there and the guy was shooting me,’” says Ebert.

Virtual reality could also allow judges and juries to experience another person's line of sight, says Bailenson, which could be useful when figuring out if a witness could have seen a suspect. But this could have an unintended effect, cautions Damian Schofield at the State University of New York in Oswego, who develops digital reconstructions. “Think of a murder scene: whether you view it from the point of view of the murderer, the victim or a third person will totally change your perception of what's happening.”

Before the forensic holodeck can be used in court, Ebert's team will have to ensure it accurately represents 3D environments. But Bailenson thinks that virtual reality could soon play a role in courtrooms around the world: “There is an arms race among big tech firms, and there are going to be high quality, cheap head-mounted displays very soon.” ■



REUTERS

See through their eyes

Deep life may add new twist to evolution

CAN evolution happen within a lifetime rather than over many generations? Bacteria living beneath the sea floor seem to be showing that it can. Even though they are unlikely to be reproducing and undergoing traditional natural selection, they carry more genetic changes than their cousins nearer the surface.

Over the last 30 years, it has

become clear that microbes survive several kilometres underground. But nutrient levels drop off so rapidly with depth that these mysterious “intraterrestrials” can barely function, let alone reproduce.

To find out if they show adaptations to living in deep environments, Brandon Briggs at Miami University in Oxford, Ohio, and Frederick Colwell at Oregon State University in Corvallis sequenced and compared genomes of Firmicutes bacteria sampled 21, 40 and 554 metres below the floor of the Andaman Sea. The deepest sediments were dated to 8.76 million years old.

The results show for the first time that bacterial genomes change with depth: the deepest microorganisms carry more mutations than their shallower counterparts in genes coding for processes like cell division. Briggs presented the findings at the American Geophysical Union Fall Meeting in San Francisco last month.

It's not yet clear if the mutations help bacteria survive or are harmful.

“Bacteria several kilometres underground may be surviving for hundreds of thousands of years”

“They could indicate that the bacteria go through many generations within the deep biosphere,” says Hans Røy at Aarhus University in Denmark. However, there seems to be too little energy available at such depths to allow the microbes to reproduce.

Yet, in theory, bacteria in these environments grow so slowly that they may survive for hundreds of thousands of years. So if you take evolution in its broad sense to mean genetic changes across the population, then it might be occurring even without cell division, says Briggs. Colin Barras ■



Beaten to death

When conservation efforts lead to slaughter

SURROUNDED by a wall of fire and angry Tanzanian villagers, the elephants were forced off a cliff some 50 metres high. When the dust settled, six of the herd lay dead. The now jubilant crowd took selfies among the carcasses.

It was a violent climax to a long-simmering conflict, which saw farmers regularly lose harvests as protected elephants raided their crops. But on that summer's evening in 2009, the inhabitants of West Kilimanjaro reached breaking point, says Sayuni Mariki at the Norwegian University of Life Sciences.

Unfortunately, the incident is far from an isolated one. People regularly risk injury and prosecution to attack protected wildlife. Tigers and leopards have been beaten to death, wolves are illegally hunted and birds of prey fall victim to poison, to name just a few.

On the surface the motives seem simple: protecting people and their property. Scratch a little deeper though, says Mariki, and it becomes clear that the animals are often just convenient scapegoats. The real hatred is reserved for conservationists

and government officials.

Mariki arrived in West Kilimanjaro in the aftermath of the elephant killings to find a disenfranchised and disillusioned village. Conservation policies had restricted access to ancestral lands, reducing the settlement to an island in a sea of game reserves. Locals watched powerlessly as private safari operators and government officials became rich from the

"Local communities feel that wild animals are valued more than people by the authorities"

booming tourist trade, while their crops were regularly destroyed.

"Local communities feel that wild animals are valued more than people by the authorities," says Mariki. Her interviews with those involved in the slaughter, now published, reveal that killing the elephants was as much about rebelling against this state of affairs as protecting crops and livelihoods (*Land Use Policy*, doi.org/xz8). Similar motivations appear to drive violence in Bangladeshi villages plagued

by tiger attacks (*Biological Conservation*, doi.org/xz9).

So what is the solution? Governments should stop imposing conservation rules on communities and instead involve them in discussions, giving them power over how wildlife protection is carried out on their lands, says Francine Madden of the conservation group Human-Wildlife Conflict Collaboration.

Offering local people a social or financial stake in conservation seems to have worked in East Africa. Here, lion-killing Masai warriors have swapped spears for radio antennas and are now among the species' most dedicated guardians (*Conservation Biology*, doi.org/xz2b).

And in the Sundarbans region of Bangladesh a charity called Wild Team is training villagers how to deal with tiger incursions – and tiger killings are down as a result. Locals no longer feel powerless and so are less likely to take out their frustrations on an unlucky big cat, says Chloe Inskip at the University of Kent, UK, an author of the study on tiger killings in Bangladesh. "If you don't understand these deeper levels of the conflict, it is just like putting a plaster on it without getting to the root of the problem," she says. Jan Piotrowski ■

Celebrate your fat - it's fighting off infection

MOST of us aren't fond of our flab but perhaps it's time to see it in a new light. Fat cells may be among our first line of defence against pathogens.

"Fat has an additional role we didn't suspect," says Jay Kolls of the University of Pittsburgh.

Beyond physical barriers such as skin, our main protection against marauding bacteria and viruses is the immune system. This is a complex network of cells with sophisticated weapons such as antibodies, which recognise and destroy foreign cells and proteins. But although many microbes multiply rapidly, it can take days for antibody production to ramp up. It now seems fat cells also play a defensive role – and they respond more speedily than many parts of the immune system.

A team led by Richard Gallo of the University of California, San Diego, injected mice with *Staphylococcus aureus* bacteria under the skin. Within hours, the subcutaneous fat cells had released a chemical called cathelicidin. This is thought to disrupt bacterial cell membranes and is also known to harm viruses, although it is unclear exactly how. Compared with these animals, another set of mice that had been genetically modified to have hardly any fat cells developed much worse infections when exposed to the bacteria. This suggests the cathelicidin-producing fat cells had a protective effect.

Gallo's team was also able to show that human fat cells grown in the lab secrete cathelicidin, so something similar may happen in people (*Science*, doi.org/x2w).

But more fat does not equal more protection. In fact, people who are obese have a higher rate of soft-tissue infections. Kolls thinks this might be because obese people are more likely to have type 2 diabetes, in which fat cells are resistant to insulin. This may also reduce cathelicidin production. "A little bit of fat is good – too much is not good," he says. Clare Wilson ■

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Climate change bears down on hapless pandas

GIANT pandas, prepare to move out. Shifting these creatures to distant reserves may be essential if they are to survive the likely impacts of climate change.

Pandas are well known for their picky bamboo diet and lacklustre sex lives. Wild populations have been reduced to a tiny gene pool and are under new pressure from the explosive growth in road-building in China. Taking these factors into account, Ming Xu of Rutgers University in New Brunswick, New Jersey, and colleagues have modelled how pandas' geographical range could be further affected by climate change.

They found that even the most conservative scenarios, which foresee an average of 1 °C warming globally by 2100, could result in habitat suitable for pandas more than halving by 2070 (*Biological Conservation*, doi.org/xz7). To make matters worse, panda populations could also become more fragmented. Xu's analysis predicts that the average size of panda habitats would decrease by about 19 per cent. That means small groups, such as the 29 animals that live in the Daxiang mountains of south-west China, could become cut off from the rest of the population and face a greater risk of dying out.

On the upside, Xu predicts that some areas to the north of the pandas' current mountainous homelands could become suitable. Planting bamboo there now could prime them for panda relocation in the future.

Booze hits immune system immediately

HAD one too many? Alcohol can wreak havoc on your immune system from the moment you start imbibing.

Majid Afshar, who treats trauma patients at Loyola University Health System in Chicago, wondered if alcohol consumption might affect his patients' immune functioning, and hence their treatment.

He and his colleagues asked

volunteers to down 4 or 5 shots of vodka within 20 minutes – taking them over the drink-driving limit. They took blood samples from the participants over the next few hours.

The team isolated immune cells from the samples, presented them with proteins found on potentially harmful bacteria and measured their response. They found that, at first, the immune

system ramps up, but within a few hours there is an anti-inflammatory phase during which its responses are weakened (*Alcohol*, doi.org/xvn).

It is the first time immediate effects of alcohol on the human immune system have been observed. If binge drinking can start affecting a person's immune system – and the way they respond to illness or injury – within an hour, doctors should take this into account, says Afshar.

Volcanic iron held back complex life

THOSE darned subsea volcanoes messed up our arrival. The iron they spewed out seems to have poisoned the microbes needed to produce enough oxygen for complex life to take off.

Cyanobacteria can release oxygen through photosynthesis. Elizabeth Swanner of the University of Tübingen in Germany and her colleagues exposed modern cyanobacteria to levels of iron present in the primordial oceans. The microbes' ability to release oxygen fell by up to 70 per cent (*Nature Geoscience*, DOI: 10.1038/ngeo2327).

"The next logical step is to ask how this delayed the evolution of oxygen-demanding life forms," says Swanner. Cyanobacteria appeared 3 billion years ago, but it took another half a billion years before oxygen levels could support complex life. Swanner's finding may help to explain the long wait.

Bright black hole blasted early Earth

LIFE on Earth could once have been seared by the galaxy's heart.

Some black holes are ringed by discs of glowing hot matter, but the one at the Milky Way's centre shines only at radio wavelengths. There is evidence that it used to be more active, though, so Xian Chen and Pau Amaro-Seoane from the Max Planck Institute for Gravitational Physics in Potsdam, Germany, modelled its past behaviour. They found its X-ray output, as seen from Earth, could once have matched the sun's.

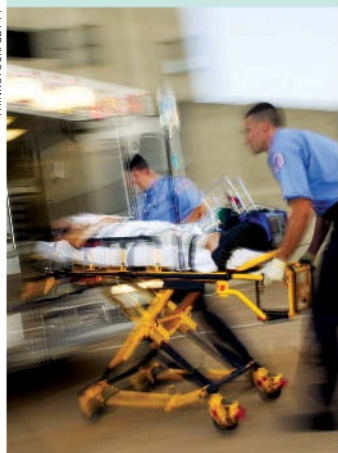
If so, early Earth could have been bathed in X-rays as if hit by a modern solar flare, but for much longer periods. This would have disturbed the ancient ozone layer and ionosphere, perhaps harming early life (arxiv.org/abs/1412.5592).

Heart surgeons away? No sweat

IF YOU have a serious heart problem just when the top surgeons are away at a medical conference, take heart. Their absence could increase your chances of survival.

Harvard Medical School healthcare policy researcher Anupam Jena and colleagues examined tens of thousands of people who were admitted to hospital with a heart attack, heart failure or cardiac arrest between 2002 and 2011. Among the most severe cases of cardiac arrest, 70 per cent of those admitted when no cardiology conference was taking place died within 30 days. But among those admitted when expert cardiologists were away at meetings, the corresponding death rate was 60 per cent (*JAMA Internal Medicine*, doi.org/xzw).

The results suggest that for the most seriously ill heart patients, the risks of emergency interventions such as artery widening may outweigh the benefits, Jena says. The findings should not lead to a change in doctors' practice without further research, but should be seen more as a warning signal that very ill people sometimes receive too many interventions. "All patients are not the same: the risk that they can tolerate is very different," he says. "In some cases that might mean we have to treat patients more conservatively."



Jupiter's eroding core may already be just a husk

THIS gas giant is rotting at the core. According to the most precise calculations yet, heavy elements from Jupiter's core are diffusing into its gassy body about twice as fast as previously thought.

Jupiter formed when rock and ice from the disc of material around the young sun coalesced. The gravity of this dense core then swept up 300 Earth-masses of hydrogen and helium. The rock and ice sank to the centre of the gas giant, but it won't stay there forever. Earlier calculations

treating atoms in the core as billiard balls found that every so often, some of them will detach and mix into the surrounding hydrogen and helium – that is, the core will dissolve like a sugar cube in water. But it was unclear how fast that process would be.

Now, Hugh Wilson at RMIT University in Melbourne, Australia, has used a quantum-mechanical model to calculate how carbon, silicon and iron – three key elements in the core – would diffuse into the fluid layer. His model found diffusion rates

twice those calculated by the earlier models. When the Juno spacecraft arrives at Jupiter in 2016, he says there might just be "a partially eroded husk of the planet's original core" (*Icarus*, doi.org/xwp).

"Juno will give us excellent data on Jupiter's gravitational field, but that's not enough information to work out the interior structure on its own," Wilson adds. Core erosion may complicate analysis, so Wilson says it's important to pin down its rate to make sense of Juno's view of Jupiter's insides.

Secret of cancer's insidious spread

TO INVADE different parts of the body, cancer cells learn to switch between two modes of moving. Now we know how.

Many types of cell move around the body. For example, fibroblasts move in to help skin wounds heal, using adhesive forces to slide forward. If the cut gets infected, white blood cells rush in propelling themselves using electrostatic forces, among others.

Many invasive cancers have learned both methods, switching between them to suit their environment. To find out how, Erik Sahai from Cancer Research UK in London looked at cells moving in the egg sac of fruit flies and tweaked genes to work out which proteins are important for this. Next, he searched databases to see if any of these proteins also go awry in cancer, hitting upon a bundle called the STRIPAK complex.

Without these misbehaving proteins, the cells are locked into the "fibroblastic" mode and are less dangerous, says Sahai. He plans to look at whether people with these proteins are more likely to have invasive cancer, work which could guide treatment (*Nature Cell Biology*, doi.org/xzv).



NATURAL HISTORY MUSEUM/ALAMY

The crab that thinks it's a frog

IS IT a frog? Is it a crab? One look at a frog crab leaning forward on its front legs explains its name, but how these curious animals evolved has long been a mystery.

Ranina ranina, pictured, is the largest and best-known of the frog crabs. Its long, narrow body and paddle-like limbs look uncannily frog-like but its hard shell and 10 legs mark it out as a crab, and a true one at that, rather than a crab only in name like a hermit crab. Most true crabs have bodies at least as wide as they are long, and they scuttle sideways. Frog crabs, however, are slimmer

and move forward and back.

People used to think that frog crabs were very primitive because of their odd-looking long bodies, says Javier Luque of the University of Alberta in Canada. Now, having reanalysed the fossil record, Luque has shown that they actually evolved after what we think of as modern crabs.

He says frog crabs evolved their narrow bodies as they adapted to burrowing into ocean-floor sediments, starting about 125 million years ago (*Journal of Systematic Palaeontology*, doi.org/xzz).

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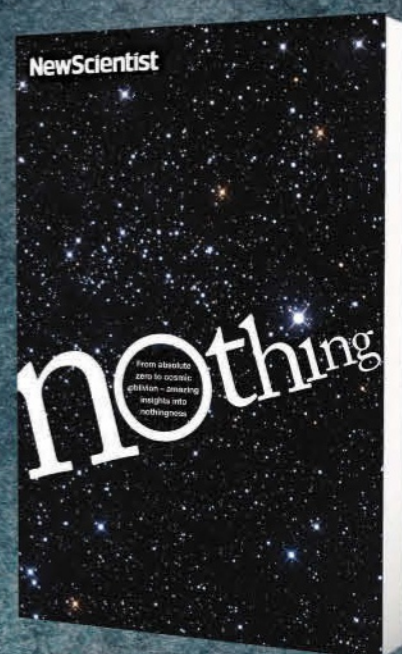
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An unexpected taste sensation

Cooking by numbers

Could Watson's supercomputing power help **Niall Firth** inject some pizzazz into his cooking?

I LIKE to think I'm a pretty good cook. I'm adventurous, have a decent understanding of the techniques required and I haven't poisoned anyone – yet. But I still find myself cooking the same tried-and-trusted favourites, using the same old ingredients.

To shake things up, I ask to test the prototype of a cooking app that uses the brain of IBM's Watson supercomputer to invent new dishes.

The key to the ChefWatson app is the supercomputer's ability to devour large amounts of information and make links between chunks of it. It has already proved its mettle by winning the quiz show *Jeopardy!* and is being used to help doctors make cancer diagnoses at Memorial Sloan Kettering Hospital in New York. Now it is attempting to do something computers usually find difficult: using creativity to invent recipes people will actually want to eat.

To provide the data, IBM teamed up with US recipe website Bon Appetit. This has a database of more than 9000 recipes, tagged according to their ingredients, type of dish and cooking style – Cajun or Thai, for example. Watson creates a statistical correlation between ingredients, styles and recipe steps in the database and uses this to work out which ingredients usually go together

and what each type of food requires. "That's how it knows that a burrito, a burger and a soup all need different elements," says IBM's Steve Abrams. "It knows a burrito always needs a wrapper of some sort, whereas soup always needs liquid. That's how you don't get a runny burrito."

To use the app, the cook first types in an ingredient they want to use. Next, they decide the

amount of experimentation they want Watson to take, ranging from "Keep it classic" to "Surprise me". Watson then offers the cook further ingredients, styles and dishes that it thinks usually go well with the initial ingredient. They can promote or exclude ingredients by clicking the "Love it" or "Hate it" buttons. Finally, the cook hits search, and Watson analyses its database to come up with a range of basic recipes that can then be further tweaked to make them more or less experimental.

If the cook wants to ramp it up, a database of flavour compounds found in a wide range of foods is also consulted and used to combine ingredients that should theoretically fit together, such as vodka and Brussels sprouts, or cauliflower and chrysanthemum. Psychological research into what flavours people find more or less pleasant is taken into account (*PLoS Computational Biology*, doi.org/fsw6fd), as is a "surprise" score for combinations of ingredients: the higher the score the less often they are found in recipes together.

"As you move to the experimental end of the scale, you're looking less at what ingredients go nicely together and more at the flavour compounds that the ingredients have in common," says Abrams. "It works out what things might go together that you'd never think of."

Well, that's the theory at least. ➤

THAI TURKEY STRUDEL - À LA CHEFWATSON

Serves 6

INGREDIENTS

450g turkey
Frozen pastry
Half a seeded, minced Thai chili
1¼ tsp rice flour
Dash lemongrass
Green curry paste
1¾ head lettuce
500g potato, chopped
13 spring onions, chopped
1½ tsp vegetable oil

Olive oil spray

115g Gruyère, diced

100g provolone cheese

SUGGESTED STEPS

- 1. Cook lettuce in boiling water**
2. Drain and squeeze dry
- 3. Heat vegetable oil**
4. Add spring onions and Thai chili and sauté for about 7 minutes
- 5. Finely chop turkey, cheeses, lemongrass and rice flour**
6. Transfer to bowl and stir in spring

onions, lettuce and potato

7. Season with salt and pepper

8. Preheat oven to 180°C

9. Spray large baking sheet with oil

10. Stack pastry in layers and spray with olive oil

11. Spread turkey mixture down centre of pastry

12. Fold short sides of pastry over filling, then roll up into log

13. Bake for about 40 minutes

14. Spoon green curry paste on the side and serve

◀ From my culinary forays, it's easy to see why the app is not yet deemed ready for launch. In a creamy pasta dish (I had opted for the "elegant" style), crème fraîche had been replaced by a glass of milk. Another time, with a high experimental setting, Watson told me my tuna bake needed half a kilo of goose meat. I declined.

It was occasionally inspired. As I ramped up the surprise element, Watson suggested I replace clam juice in a classic gumbo dish with the Japanese soup base dashi. It worked – giving the dish a deep savoury flavour that I would never have thought to try out.

Michael Laiskonis, creative director of the Institute of Culinary Education in New York, was one of the first professional chefs to help guide Watson. "It lets you organise creativity in a more structured way, rather than just going in the kitchen and experimenting," he says.

The plan is for ChefWatson to become more sophisticated and to suck in data from more sources, says Florien Pinel, the project's lead software engineer. It already scours Wikipedia's world cuisine pages and looks up nutrition facts in a US Department of Agriculture database for help on determining ingredient proportions.

Apart from the occasional odd ingredient combination, there are a few other bugs in the way ChefWatson conjures creative recipes out of pure data. One tester, Matt McSherry, says it seems to struggle with portion size. Another found that a recipe called for precisely 554 juniper berries, and she was also told to "skin and bone" her tofu.

Overall, McSherry is loving the experience. "I get to muck about in the kitchen with a thinking, reasoning supercomputer. That's pretty exciting right there," he says. "It's the future we were promised as children." ■

To try ChefWatson, go to bit.ly/watsoncook



Gamers united

Return of the arcade

Interactive games can reboot an 80s fixture, says **Douglas Heaven**

TWO people in home-made sleeping bags, heads stuffed into makeshift boxes, wriggle around on the floor. By twisting left and right they each move a caterpillar on a screen. A small crowd cheers them on. This is *ROFLpillar*. Welcome to the future of the video game arcade.

"Games aren't just about the things happening on a screen, they're about the people playing them," says Iain Simons, director of the annual GameCity festival in Nottingham, UK, which celebrates video games by setting up public game spaces across the city. "In *ROFLpillar* only the players can see the screen. But they're creating a performance that you watch."

Public gaming has come a long way from traditional arcades, with their rows of coin-eating cabinets. Over the last decade or so, with the

rise of consoles and online play, gaming has become something we do at home, and arcades have mostly closed down in the West – although they survive in Japan. Now they are getting a reboot. The GameCity festival is just one of many events that aim to introduce

"The best way to learn about games isn't always to play them. It's to make them too"

the wider public to the variety of experiences that video games can now offer.

A permanent space is next. We have live venues for music and film where people come together to share experiences, says game designer Alex Fleetwood, who ran the experimental game studio *Hide&Seek* until it closed last year.

"What's the equivalent for games?"

Simons has one answer. In March, he will open the doors to the first National Videogame Arcade (NVA), a five-storey building in the centre of Nottingham. It will be both a place to play games and a video game counterpart to the British Film Institute, with public lectures and exhibition spaces. The £2.5 million project – supported by organisations including Nottingham Trent University and the city council – is a far cry from the old arcades.

For one thing, the building itself will be playable – a platform for its own games. Many components, including the building's lighting, sound system and temperature controls, will be open to manipulation. "We're building a PlayStation but it's a

building,” says Simons.

At the end of this month, the first games designed specifically for the space will be announced. “But this can’t just be a thing for bearded men in their 30s to get excited about,” says Simons. As a public space, the NVA is also aimed at families and schools. Simons is excited about commissioning celebrated game designers, but says it is equally important that a 10-year-old can come in and program the building’s LEDs to chase each other around the walls.

Screen-free gaming

“There are going to be a lot of games that people recognise,” Simons says. Classic arcade games like *Pac-Man* could sit alongside console hits like *Tomb Raider*. “But this is as much about making,” he says. “The best way to learn about games isn’t always to play them. It’s to make them too. And this will be a home for that activity.”

The NVA may be the most high profile UK project to date, but there’s a big revival in arcades, says London-based game designer George Buckenham.

“There are at least four gaming bars in London now. That wasn’t the case a few years ago.” The same is happening in the US, with venues like the LA Game Space and Barcade in New York.

Then there are events like Wild Rumpus, which Buckenham helps organise. This and other evening events are showcases for experimental games, like *ROFLpillar*, that use screens or controllers in novel ways. Many do without screens entirely.

QuickDraw – a homage to gun-sliding Westerns – uses the PlayStation Move motion controller as a pistol in a game where the fastest-drawn controller wins. In *Johann Sebastian Joust*, players must hold their Move controller as steady as possible while trying to jostle others into moving theirs – all to the accompaniment of J.S. Bach’s

Brandenburg Concertos. Without the need for screens these games can be set up and played almost anywhere, even outdoors.

Similarly, *Searchlight* – designed by Hide&Seek – uses Microsoft’s Kinect motion sensor in a game where players have to move objects out of the game space without being caught by a roving spotlight. It is played on the floor, again without need for a screen.

The mix of digital and physical elements helps make games more accessible. Unlike in traditional arcades, the idea is to cater for people who are not typical gamers, says Buckenham. “These weird, experimental interfaces are actually a great leveller. No matter how experienced you are, you’re still going to be doing the same ridiculous thing and you’ve got a similar chance of winning.”

As Simons notes, the performance aspect is often key. Only a handful of people can play a game at any one time, but watching can be as fun as playing. “One of the main things we look at for Wild Rumpus is this sense of spectacle,” says Buckenham. “It should feel like an event, a thing you can only see there.”

For example, Buckenham has

“The weird, experimental interfaces are a great leveller. You’re all doing the same ridiculous thing”

made a game called *Punch the Custard*, specifically designed to be played in public spaces. “It doesn’t really make sense other than that,” he says. He has also made a version of the popular console game *Proteus* that is played on a trampoline. In it, you bounce around the game’s pretty, pixelated world like a giant rabbit.

Being able to enjoy watching the games – even if you don’t play yourself – is important, say Simons and Buckenham. “One of the best things to hear is someone saying, ‘I didn’t think I was into games, but this is amazing,’” Buckenham says. ■

ONE PER CENT



Raking robot's insta-art at the beach

No, it's not alien art. A robotic beach artist has created giant drawings in the sand. Developed by Paul Beardsley from Disney Research Zurich and colleagues at the Swiss Federal Institute of Technology, the wheeled robot can recreate a drawing sent to it from a phone or tablet. It computes a path across the sand that approximates the artwork and sets off. A rake attached to its rear etches the pattern in the sand. Each drawing takes about 10 minutes, and the idea is that the robot could be controlled remotely, allowing a beach to be turned into a digitally controlled sketchbook. It was presented at Techfest in Mumbai, India, in late December.

“After this talk, politicians will presumably wear gloves when talking in public”

Hacker Jan Krissler, aka Starbug, speaking at the Chaos Communication Congress in Hamburg. He claims to have copied the fingerprint of a German politician from photos of her hands

Map an entire room through a keyhole

A laser imaging technique could let spies map a room in secret. Chenfei Jin of the Harbin Institute of Technology in China and colleagues measured the three-dimensional shape and position of three cardboard letters in a room, spelling HIT, by firing lasers through a 2-centimetre-wide hole in a wall. Laser pulses bounced off walls to hit the letters before passing back through the hole and scattering into a camera, revealing the details (*Optics Letters*, doi.org/x2t).

10.8m

The number of smart watches that the Consumer Electronics Association expects will be sold in 2015. The association runs the Consumer Electronics Show, held in Las Vegas this week





Stop thief!

SWOOP - and it's gone. Hawaiians call the frigatebird "iwa", meaning thief. The metre-long bird evolved not only to hunt the seas, but to steal from those that do. Here one acrobatically grabs a piece of fish offal from the gaping jaws of a pelican.

Wildlife photographer Michael Poliza snapped this photo of a frigatebird living up to its Hawaiian name off the Galapagos Islands in October. "We were at anchor and local fishermen were offering their catch," Poliza recalls. "They were cleaning the fish and all kinds of birds were coming by. The pelican was able to scoop up this fish. As he's trying to swallow - which the pelican does by opening up his mouth and jiggling around a bit - the frigatebird comes by and scoops the fish out of the pelican's mouth, perfectly timed."

This sense of timing helps the frigatebird to catch its other favoured prey, flying fish. Frigatebirds can't waterproof their feathers, so they accomplish all this without ever touching the water, relying on agile flying. Hal Hodson

Photographer

Michael Poliza

michaelpoliza.com

The Kiwi comedown

Hailed as an alternative to the war on drugs, New Zealand's stalled attempt to end prohibition has lessons for the world, says **Ross Bell**

JUST 18 months ago, New Zealand was the talk of the world's drug law reformers. It had set up a system to allow new recreational drugs to gain official approval and be sold legally. Moreover, it had won sweeping parliamentary support for this – the Psychoactive Substances Act was passed with a solitary vote against. It seemed that a government had finally taken the bold step towards ending prohibition.

And yet now it is far from clear that the law will ever be used to approve a drug. A panicky government amendment may have made it unworkable. What happened has lessons for others seeking a better way than the failed “war” on drugs to minimise the problems related to psychoactive substances.

The act was meant to establish a process for new psychoactive substances to be tested and, if posing only “a low risk of harm”, approved for sale. Regulations would cover testing, importation, manufacture and sale. Politicians seemed to understand that “low risk” did not mean “no risk”.

The law was attempting to get to grips with a market that had been raging for years. Designer drugs were emerging one after the other in a chaotic, unregulated retail environment before being declared illegal. For example, the “party pills” BZP and TFMPP appeared in New Zealand in around 2000 and were banned in 2008. No deaths had been attributed to them and they may have reduced methamphetamine use. But they were associated with binge drinking and emergency



hospital admissions. By the time they were banned, 1 in 5 New Zealanders had used them.

In 2005, the first in a series of synthetic cannabinoids reached New Zealand. They were progressively outlawed, but each time one with a slightly different chemical structure would pop up. Eventually, associate health minister Peter Dunne accepted that this game of whack-a-mole could not continue and championed the new law.

The act established an “interim period” in which some products and suppliers could apply for temporary licences while the final regulations were written. All the drugs granted interim licences

were synthetic cannabinoids.

At the same time, the wider market was sharply curtailed. The number of retail outlets for “legal highs” was slashed, from as many as 4000 to fewer than 170. The number of products fell from around 200 to fewer than 50. There was evidence that related hospital admissions fell, along with reports to the National Poisons Centre.

The purge also magnified attention on the remaining outlets, largely unwelcome

in their communities. They became a focus for the media. Some looked disreputable when journalists visited. In addition, personal stories of chaos and woe received widespread coverage. That these problems had developed in the unregulated market or were caused by products already removed were of little consequence.

On top of this, an already under-resourced regulatory authority was sluggish to respond. The interim regime was left carrying more weight, and for longer, than had been anticipated. Imports could not be checked for purity as required, and obtaining and delivering certificates of analysis proved a challenge for all concerned. It became difficult to say exactly what was in some products – the very opposite of what had been intended.

Despite these problems, perhaps the real damage was done before the act was even passed. The early, relatively benign synthetic cannabinoids had been banned for years. When the act passed, only so-called third-generation cannabimimetics were still legal. Their harms were poorly understood.

In May, amid the media panic, the government rushed through an amendment ending the interim licensing period and removing all the drugs from sale. The act remains in place. Indeed, it's in good shape. The long-awaited regulations for manufacturing, importing and research and product approvals were signed off in July and are in force. Those for wholesaling and retailing are on

“All drugs are again illegal and thus back in the black market. Familiar patterns of abuse are returning”

track for the second half of 2015.

But one part of the amendment has thrown a bomb into the works. It banned the use of animal testing results, in New Zealand or elsewhere, to show that a product met the “no more than a low risk of harm” standard. But a senior Ministry of Health official said recently that “at this point in time, it is not possible to have a product approved without animal testing”.

The idea of a law that applies similar testing standards to these substances as any other approved drug – to ensure it is not genotoxic for example – is now broken. All recreational drugs are outlawed, and thus back in the hands of the black market. Familiar patterns of substance abuse are returning to the street and the internet is still a broad channel for the import of untested drugs. Chances of the animal-testing ban being rescinded look slight for now.

The lessons? The interim period may have caused more problems than it solved. The delay in introducing a proper regulatory infrastructure was harmful. But more than that, New Zealand’s experience has shown the perils of attempting to regulate new psychoactive substances without reviewing drug law as a whole. The first synthetic cannabis product, having been on the market for five years unnoticed and problem-free, was banned under the vague, sweeping analogue provisions of the country’s Misuse of Drugs Act. How different might things have been if that product had still been around?

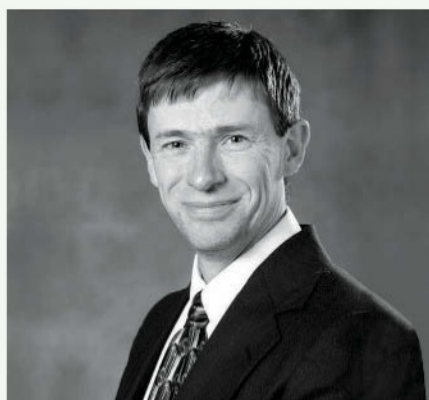
It makes little sense to deal with new substances in isolation. If there is a solution to the difficult problem of seeking alternatives to the war on drugs, it very likely lies not only in looking forward, as New Zealand attempted, but also looking back and reflecting on the laws we already have. ■

Ross Bell is executive director of the New Zealand Drug Foundation, which aims to prevent and reduce harm from drug use via evidence-based policies

ONE MINUTE INTERVIEW

Flies aren’t all bad

The common housefly is both friend and foe – it spreads disease but may also help us fight it, says **Jeffrey Scott**



PROFILE

Jeffrey Scott is a professor of entomology at Cornell University’s College of Agriculture and Life Sciences in Ithaca, New York. He researches insect genetics, insecticide resistance and evolutionary biology

You led recent efforts to unravel the common housefly genome. Why is this important?

It is an insect that transmits a lot of diseases to humans and to animals. It also rapidly evolves resistance to insecticides, so having the genome sequence will help us research how resistance develops so we can try to tackle it.

Does the housefly pre-date humans?

It is not entirely clear, but it looks like houseflies and humans co-evolved. The spread of humans from Africa to the rest of the world is similar to that of houseflies, which also migrated out of Africa. This is a species that was very much tied to human activities: the availability of human and animal waste provided sites for laying eggs and larval growth. If humans died out, the housefly would probably go too.

Tell me about the housefly’s dark side.

They transmit a few hundred different diseases. They have the ability to move a pathogen from a source fluid to our food, for example, or directly

into our eyes. As long as the pathogen in the source is concentrated enough, this can cause disease. A good example is fly-transmitted trachoma. The World Health Organization says this is the cause of 6 million current cases of blindness, with houseflies a major carrier. There is an ongoing debate about whether they can transmit the Ebola virus.

Could knowing the housefly genome help prevent the fly-based spread of disease?

New technologies allow us to turn genes off – things like RNA interference. Potentially we could give flies a bait containing RNA that turns off an immune gene that protects them against one of the diseases they carry. This would be a species specific, environmentally safe control method.

But you also think we should appreciate houseflies a little more?

Certainly. They’re a nuisance and we would prefer them not to make us sick, but they do good in the world too. In the aftermath of the earthquake and tsunami in the north of Japan in 2011, houseflies were obviously a concern in terms of transmitting diseases, but a colleague saw that they were also very important in decomposing the mess that was created. They are also beneficial as decomposers of animal waste in livestock facilities. If the massive amounts of manure generated at farming facilities were not decomposed by fly larvae, it would create a big environmental problem.

Could we turn any of the housefly’s genetic weapons to our advantage?

Houseflies have a significant number of antimicrobial peptides in their saliva. There has been a longstanding practice of treating wounds with fly larvae. This is usually done with blowflies, but houseflies have been used as well. If you isolate the gene that makes the antimicrobial peptide, you could potentially make it in the lab and produce buckets of it. The possibility of sourcing new antimicrobial compounds from the housefly is a real one.

Interview by Jon White

First an asteroid, then Mars

We can't put people on the Red Planet yet, but just wait till the 2030s, says NASA chief scientist **Ellen Stofan**

In the next decade, NASA's Asteroid Redirect Mission (ARM) aims to capture an asteroid, put it into orbit around the moon and then send astronauts to it. Why?

The mission has critical technologies that we need to develop for our ambition to get people to Mars, such as solar electric propulsion, which is a fuel-efficient way to move cargo slowly. We'll need that technology to deliver bulky supplies to Mars in advance of a crew's arrival. The astronauts can't haul much cargo because they need to get to Mars in a smaller, faster vehicle to ensure less exposure to the hazardous space environment.

Republicans now control the US Congress and some want to pull the plug on ARM. What's your message to them?

If we are going to get people to Mars in the 2030s – which is an important goal and one that I think has strong bipartisan support – then we need to make a convincing argument that we have to test new technologies in a stepwise fashion. While I wish we could get humans to Mars in 2025, we simply don't have the technology, so we have got to find bite-sized, affordable chunks that we can do one at a time to get to where we're going. NASA feels strongly that ARM is the first bite-sized chunk that fits within a responsible budget.

When Barack Obama became president, he switched focus from a return to the moon to putting humans on Mars. Did you approve? I thought that was a great move. I want to find out if there's life on Mars and the only way I think we are going to do that is by sending

PROFILE

Ellen Stofan is a planetary geologist and NASA's chief scientist. She is an associate member of the Cassini mission to Saturn and a co-investigator on the Mars Express mission's MARSIS experiment

astronauts and a laboratory there to answer that question. When you get too focused on the moon, you start developing all kinds of technologies that you actually don't need to get to Mars.

Aren't crewed missions a distraction from the science objectives, given their added cost and complexity?

What we can accomplish scientifically by putting scientists on the surface is huge. And it's not just about overcoming the 10 minutes it takes to relay commands from Earth to the rovers on Mars – it's about human intuition. I'm a trained geologist: I can read a landscape, I know which rocks to pick up and knock open, and when to move on to the next one. Do you know how far the Mars rover Opportunity has

moved in 10 years? Twenty kilometres. I can go 20 kilometres in a day. OK, maybe I'd move more slowly on Mars, maybe I'd only go 10 kilometres in a day. Robots are great, but at this point they have nowhere near the capability of a human. As much as I love our rovers, a human can do in hours what it takes robots years to accomplish.

Current Mars rovers were sent with no experiments that would detect life directly. Was that a mistake?

Research has shown that cosmic radiation would sterilise the upper 2 metres of Mars in a fairly short period – probably just thousands of years. We don't yet have the capability to access the depths where scientists are more optimistic there could still be extant life.





Will the next NASA rover, the Mars 2020 lander, be able to dig down 2 metres?

It has the ability to drill, but not that deep. We are going to be drilling to take a core sample, but we are talking centimetres in depth, definitely not even a metre. That sample will be cached. We will use remote sensing instruments to look at the hole, but the core itself will go into a container for possible pick-up and return to Earth in the future.

Will samples of Martian soil have to wait for a crewed mission to pick them up?

I'm optimistic that we can do it sooner. Going to Mars, landing a lot of mass on the surface, taking off, rendezvousing in orbit, returning to Earth... that's the story of sending humans to Mars. Don't we want to do that in a

completely robotic way before we risk sending humans to do the same thing?

What types of experiments do you favour sending to Mars to answer the life question?

Chiefly a sophisticated mass spectrometer that can not only detect whether organics are present, but can also identify exactly what they are. And imagers to look at microscopic features in rock in case there could be any fossils. We don't think the time frame in which life could have existed on Mars was extraordinarily long, so we are not anticipating extremely complex life forms, but instead single-celled, perhaps multi-celled organisms. They are going to be hard to find.

Ultimately we still need to bring back samples to do sophisticated analysis. That also

means that when technology advances we will still have a sample on which to perform more tests. Remember, we are still looking at moon rocks 40 years on and learning new things.

How hard will it be to get clear proof of life?

The complex thing is going to be getting the scientific community to agree that what we are seeing is real evidence of life. That's where

"I love our Mars rovers, but a human can do in hours what it takes robots years to do"

the rub is going to come. People love to think that scientists all agree, but in reality we like to argue. Any evidence we find is going to create a big scientific debate, unless it looks just like life on Earth. That's why I'm so keen on sending people to Mars. I think it's going to take human sampling and analysis in situ to actually figure it out.

What are the main barriers to putting people on Mars?

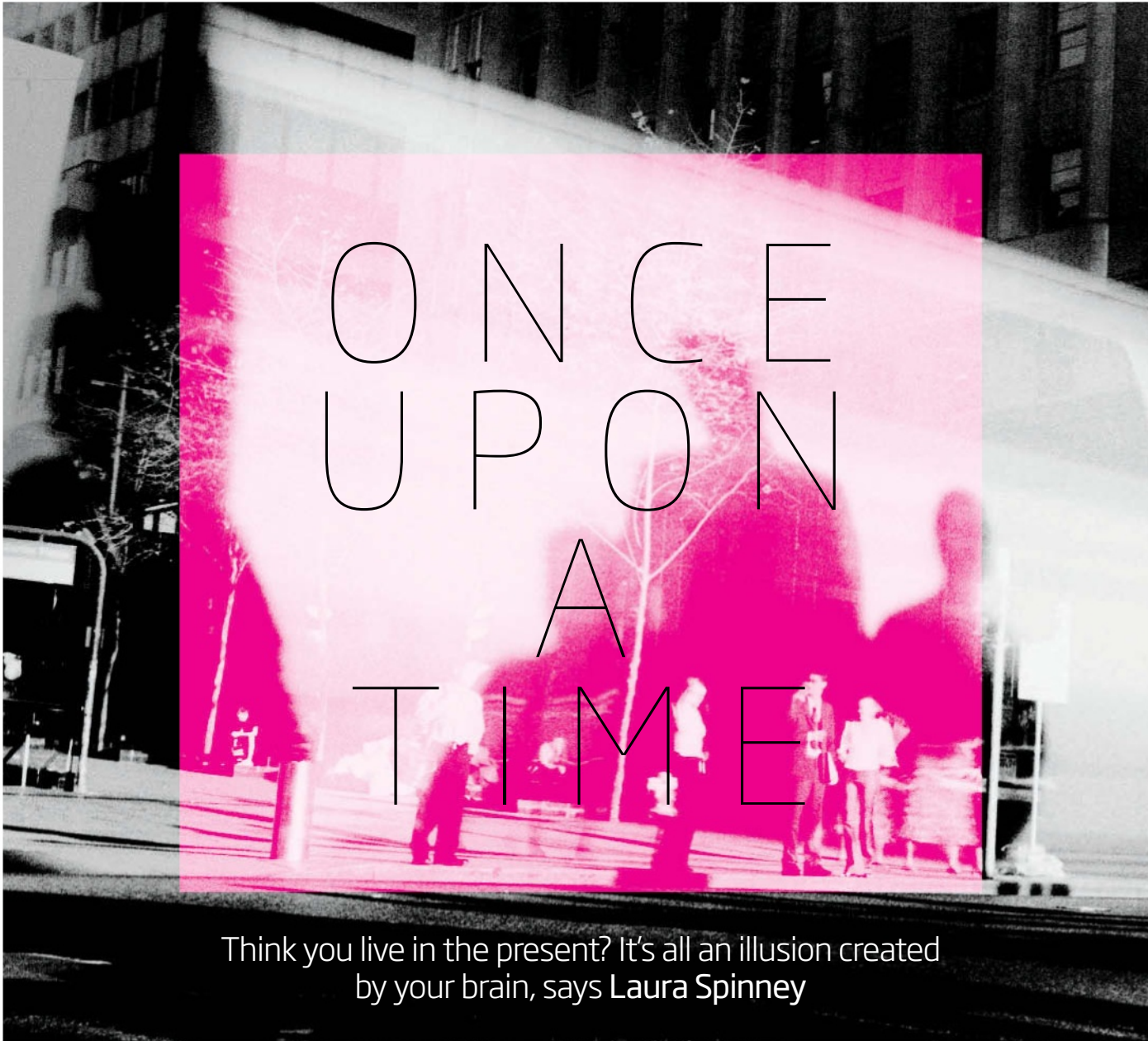
We understand from instruments on earlier missions that you would get an unacceptably high dose of radiation, mostly due to cosmic radiation, on the journeys between Earth and Mars. We haven't figured out yet how to completely shield people from that.

Also, astronauts have to be able to get up and work when they get to Mars. We saw a crew that returned recently after six months on the International Space Station. They had to be helped out of the capsule. It takes a while to adjust. How are we going to make sure that when astronauts get to Mars – after a journey of at least six months – they are healthy enough to work and return home? We have a lot of work to do, mostly on the space station over the next 10 years, to learn how to mitigate the effects of microgravity on humans.

What's your take on private projects aiming to get people to Mars in the next decade?

If someone says they can do it in the 2020s, boy do I want to see how they are doing atmospheric entry, descent and landing. Our goal is to land astronauts safely and get them home, but we don't yet know how to land large amounts of mass on the surface of Mars safely. Mars has a very thin atmosphere. You arrive at really high speed and you have to slow yourself down. We are working on the technologies to do that, but we're not there yet. ■

Interview by Jon White



ONCE UPON A TIME

Think you live in the present? It's all an illusion created by your brain, says Laura Spinney

WHAT is “now”? It is an idea that physics treats as a mere illusion, yet it is something we are all familiar with. We tend to think of it as this current instant, a moment with no duration. But if now were timeless, we wouldn’t experience a succession of nows as time passing. Neither would we be able to perceive things like motion. We couldn’t operate in the world if the present had no duration. So how long is it?

That sounds like a metaphysical question, but neuroscientists and psychologists have an answer. In recent years, they have amassed evidence indicating that now lasts on average between 2 and 3 seconds. This is the now you are aware of – the window within which your brain fuses what you are experiencing into a “psychological present”. It is surprisingly long.

But that’s just the beginning of the weirdness. There is also evidence that the now you experience is made up of a jumble of mini subconscious nows and that your brain is choosy about what events it admits into your nows. Different parts of the brain measure now in different ways. What’s more, the window of perceived now can expand in some circumstances and contract in others.

Now is clearly a slippery concept. Nevertheless, it would be good to pin it down because it could tell us something about the bigger picture of how the brain tracks time. Not just that, the perception of the present is also crucial to how we experience the world. If events appear simultaneous when they aren’t, that has implications for our understanding of what causes what. “Your sense of nowness

underpins your entire conscious experience,” says Marc Wittmann at the Institute for Frontier Areas of Psychology and Mental Health in Freiburg, Germany. Understanding now even helps us address the question of whether we have free will.

We have long known that the brain contains structures that use cycles of light and dark to set its daily clock. How it tracks the passing of seconds and minutes is much less well understood. At this level, there are two broad types of timing mechanism, an implicit and an explicit one. The explicit one relates to how we judge duration – something we’re surprisingly good at. The implicit mechanism is the timing of “now” – it is how the brain defines a psychological moment and so structures our conscious experience.



STEVE MCCURRY/MAGNUM PHOTOS

Our implicit sense of time is itself made up of two seemingly incompatible aspects: the fact that we exist permanently in the present yet experience time flowing from the past towards the future. So how do successive nows get sewn together into the smooth-flowing river of time? Wittmann has addressed this question by drawing on the mass of psychophysical and neuroscientific data gathered in recent decades (*Frontiers in Integrative Neuroscience*, vol 5, article 66). He believes this points to a hierarchy of nows, each of which forms the building blocks of the next, until the property of flow emerges (see diagram, page 31).

If Wittmann is correct, to understand the now that we experience, we first need to understand its subconscious component, the

“functional moment”, which operates on the timescale at which a person can distinguish one event from another. This varies for different senses. The auditory system, for example, can distinguish two sounds just 2 milliseconds apart, whereas the visual system requires tens of milliseconds. Detecting the order of stimuli takes even longer. Two events must be at least 50 milliseconds apart before you can tell which came first.

The brain must somehow reconcile these different detection thresholds to make sense of the world. Its task is made more difficult by the fact that light and sound travel through air at different speeds and can reach our sensory apparatus at different times, even if they were emitted by the same object at the same time. How does the brain bind all the dislocated ➤

“WE EXIST
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GREG PEASE/GETTY

stimuli into a single psychological event, a functional moment?

There's good evidence that even at the subconscious, millisecond level, the brain makes predictions. This is what happens when you watch a badly dubbed movie. Your brain predicts that the audio and visual streams should occur simultaneously and – as long as the lag between them doesn't exceed about 200 milliseconds – after a while you stop noticing that the lip movements and voices of the actors are out of sync. Exploiting this effect, Virginie van Wassenhove at the French medical research agency's Cognitive Neuroimaging Unit in Gif-sur-Yvette and her colleagues have been investigating how the brain might bind incoming information into a unified functional moment. What they found is intriguing.

Mind meld

They exposed people to sequences of beeps and flashes, both occurring once per second, but 200 milliseconds out of sync. Brain imaging then revealed the electrical activity produced by these stimuli. This consisted of two distinct brain waves, one in the auditory cortex and another in the visual cortex, both oscillating at a frequency of 1 hertz – once per second. At first the two oscillations were out of phase, and the volunteers experienced the light and sound as out of sync. But as people reported that they started to perceive the beeps and flashes as being simultaneous, the auditory oscillation became aligned with the visual one (*NeuroImage*, vol 92, p 274). "The changes predict participants' conscious timing," says van Wassenhove, "so we have

Split-second timing relies on the brain's ability to predict which perceptual stimuli belong together

to hypothesise that this reflects an active mechanism of the brain to deal with time in the world." In other words, your brain seems to physically adjust signals to synchronise events if it thinks they should belong together.

This is the first time that a biological basis has been found for implicit timing. It also suggests that, even at the subconscious level, the brain is choosing what it allows into a moment. However, this functional moment is not the now of which we are conscious. That comes at the next level of Wittmann's hierarchy, with the "experienced moment". So what do we know about this?

It is this now that seems to last between 2 and 3 seconds. A neat demonstration of that was provided last year by David Melcher at the University of Trento, Italy, and his colleagues. They presented volunteers with short movie clips in which segments lasting from milliseconds to several seconds had been subdivided into small chunks that were then shuffled randomly. If the shuffling occurred within a segment of up to 2.5 seconds, people could still follow the story as if they hadn't noticed the switches. But the volunteers became confused if the shuffled window was longer than this (*PLoS ONE*, vol 9, p e102248). In other words, our brains seem able to integrate jumbled stimuli into a cohesive, comprehensible whole within a time frame of up to 2.5 seconds. The researchers suggest that this window is the "subjective present", and exists to allow us to consciously perceive complex sequences of events.

Melcher likens the effect to the way we are

able to guess a written word even if some of its letters are missing or out of place. Because we have a cohesive concept of the word, we can fill in the gaps, but comprehension breaks down if the words either side of it don't provide context, or the first and last letters have been tampered with. Melcher thinks the 2 to 3 second window provides a sort of bridging mechanism to compensate for the fact that our brains are always working on outdated information. Right now, your brain is processing stimuli that impinged on your senses hundreds of milliseconds ago, but if you were to react with that lag you wouldn't function effectively in the real world.

"Our sense of now can be viewed as a psychological illusion based on the past and a prediction of the near future," says Melcher. "And this illusion is calibrated so that it allows us to do amazing things like run, jump, play sports or drive a car." Consciously or not, Hollywood movie editors take account of our experienced moment. In the cutting room, they rarely create shots that last less than 2 or 3 seconds, unless the director is aiming to create a sense of chaotic or confusing movement. "Three seconds is long enough to understand what's going on, but not so long that you have to rely too heavily on memory to maintain access to all the relevant information," says Melcher. "It's the sweet spot."

Wittmann acknowledges that it is not clear how a group of subconscious functional moments are combined to create the conscious experienced moment. The biological signature of the experienced moment has yet to be found, although neuroscientist and philosopher Georg

Northoff at the University of Ottawa in Canada has proposed one possibility. In his 2013 book *Unlocking the Brain*, he speculated that implicit timing could be related to slow cortical potentials, a kind of background electrical activity measurable across the brain's cortex. It's telling, says Wittmann, that these waves of electrical activity can last several seconds. He also points out that consciousness is itself a kind of filter because it focuses our attention on some things to the exclusion of others. Influenced by factors such as emotion or memory, it might tag or label a subset of functional moments as belonging together, to create an experienced moment.

Creating flow

However the present moments we experience arise, they are combined to give us a sense of continuity or "mental presence", the final now in Wittmann's hierarchy. This operates over a timespan of about 30 seconds and gives you a sense of continuity. According to his model, the glue that holds the experienced moments together to create an impression of time flowing is working memory – the ability to retain and use a limited amount of information for a short time. Mental presence is what underpins the sense that it is you who is experiencing events. "It is the now of 'I', of your narrative self," Wittmann says.

The implications of this new view of nowness are potentially mind-boggling. Take, for example, the debate over free will. In the 1980s, US physiologist Benjamin Libet found

that people reported deciding to flick their wrist about 500 milliseconds after he had detected activity in their brains that preceded each wrist-flick. His now controversial conclusion was that we have less conscious control over our actions than we think. But, given what we know about implicit timing, it is possible that what he actually detected was an artefact of the brain's insensitivity to order at very small time scales. At 500 milliseconds, says Wittmann, "we are definitely within margins of temporal resolution where you cannot distinguish which event came first".

Then there's the issue of the stretchiness of now. There is plenty of anecdotal evidence that time can seem to expand or contract depending on what's happening around us – for example, that events seem to unfold in slow motion during car accidents. Such expansion has been reproduced in the lab, when people are presented with a succession of stimuli of equal length yet report that an oddball event in the series seems to have a longer duration. What's more, Melcher has preliminary findings showing that, when people perceive an event to have lasted longer than it actually did, they also take in more detail about it, describing it more accurately. In his opinion, this shows that temporal stretchiness reflects real changes in sensory processing, which in turn may have conferred an evolutionary advantage. By ratcheting up the brain's processing rate at critical moments and easing back when the environment becomes predictable and calm again, we conserve precious cognitive resources.

The now illusion

Your daily routine might be ruled by the sun, but your perception of the present moment and time passing is created by a hierarchy within the brain

Sense of continuity
The impression that time is passing
30 seconds

Experienced moment
Functional moments combine to create the now you are conscious of
2-3 seconds

Functional moment
Brain's response time to stimuli
milliseconds

Such changes in sensory processing would be subconscious, but might we be able to take control of our perception of now? Regular meditators often claim that they live more fully or intensely in the present than most people. To test the claim, Wittmann asked 38 people who meditate and 38 who do not to look at an ambiguous line drawing of a cube, known as a Necker cube, and press a button each time their perspective of it reversed. The reversal time in this kind of task is considered a good estimate of the length of the psychological present. By this measure, people in both groups perceived now to last about 4 seconds, seeming to confound the claims of some meditators. However, when Wittmann asked participants to try to hold a given perspective for as long as possible, the meditators managed 8 seconds on average, compared with 6 seconds for the others.

Meditators tend to score highly in tests of attention and working memory capacity, says Wittmann. "If you are more aware of what is happening around you, you not only experience more in the present moment, you also have more memory content." And that in turn affects your sense of the passing of time. "Meditators perceive time to pass more slowly than non-meditators, both in the present and retrospectively," he says.

This suggests that with a bit of effort we are all capable of manipulating our perception of now. If meditation extends your now, then as well as expanding your mind it could also expand your life. So, grab hold of your consciousness and revel in the moment for longer. There's no time like the present. ■

Laura Spinney is based in Lausanne, Switzerland

"WITH A BIT OF EFFORT WE ARE ALL CAPABLE OF MANIPULATING OUR PERCEPTION OF NOW"



Meditators often say the practice helps them live more fully in the present



Mapping the Milky Way

It's hard to get a handle on what's where in our galaxy – but the picture's getting clearer, says **Ben Gilliland**

HUMANITY has made great strides in probing the grand mysteries of the cosmos. We have observed the afterglow of the big bang, spied on galaxies so distant we see them as they were when the universe was an infant, monitored far-off supernova explosions and penetrated to the very edge of a black hole.

One corner of the cosmos, though, has proved resistant to our attempts to get to grips with it: the bit we call home, the Milky Way.

With the Milky Way, we are inside the thing we are trying to observe. We can only dream of zipping outside our galaxy in a spaceship to get another perspective.

So we must make do with our view from an insignificant blue blob orbiting one star out of many billions in a sprawling conurbation of stellar neighbourhoods.

It's not the best of views: from here the cosmic metropolis is obscured by a smog of dust and gas that fills up the space between the galaxy's stars. What's more, its districts are in constant motion, rotating at different speeds around the galactic centre.

Put that way, it seems miraculous we know much about the Milky Way at all. Yet slowly but surely we have begun to sketch a map of our galactic home.



Picture of a galaxy

On a clear night, away from bright lights, you can see a hazy band of light bisecting the sky. The Romans called it “Via Lactea”, or “Road of Milk” – the origin of our own Milky Way.

This strip of light gives us our first clues as to what our galaxy must look like from outside. It tells us we’re not part of an unsculpted blob of stars, but instead somewhere inside a flattened disc looking towards the galaxy’s dense, crowded heart (see “Bright lights, big city”, below).

The Milky Way’s closest galactic neighbour, Andromeda, is a flattened disc, too, with a distinctive spiral-armed appearance. Such structures form as clumps of stars and dust and are drawn together by gravity and begin to spin faster and faster around each other. As they do so, they are flattened down into a disc, rather as a pizza chef spins a dough ball to flatten it out. Any small disturbances in the motion or density of the disc’s material bunch

together over time, forming the spiral arms.

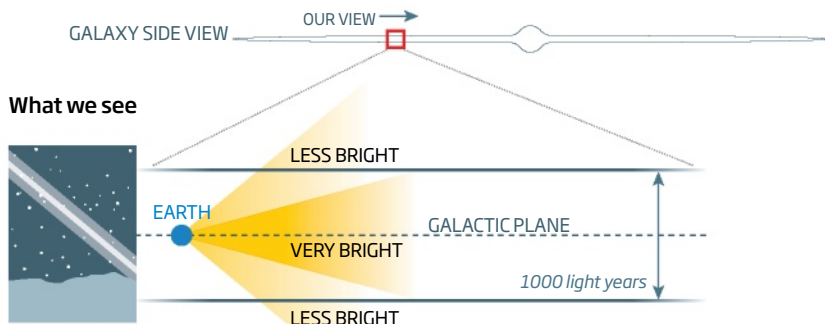
The advent of radio astronomy in the 1950s allowed astronomers to penetrate the fog of interstellar dust and begin to map the location and motion of similar denser structures within the Milky Way.

Over time, radio and infrared observations combined to create a picture of a galaxy not just with spiral arms, but also – unlike Andromeda, though like many other galaxies we see – a central, bright bar-shaped structure of stars.

The Milky Way’s dimensions have been extrapolated by mapping groups of stars called globular clusters that hang out in the outermost galactic suburbs. At 100,000 light years across but only 1000 light years thick, our galaxy has about the same relative dimensions as a CD. We are now reasonably sure that we reside about halfway out – 25,000 light years from the galactic centre – in a region known as the Orion Arm. ➤

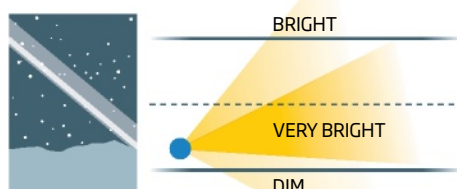
Bright lights, big city

The appearance of the Milky Way from Earth tells us a lot about our galaxy and our position within it



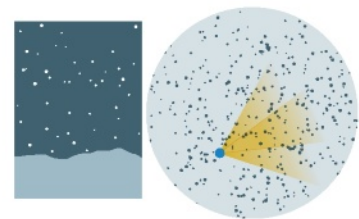
We see the Milky Way as a thin, symmetric bright strip across the sky. This tells us we are sitting in a thin disc of stars looking towards its centre, and seemingly close to the galactic plane

On a different plane

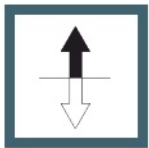


If we were significantly off the galactic plane we would see an asymmetric distribution of stars

Disc-free living



If the Milky Way were a sphere or other “3D” shape, we would see an equal distribution of stars all over the sky



Are we up or down?

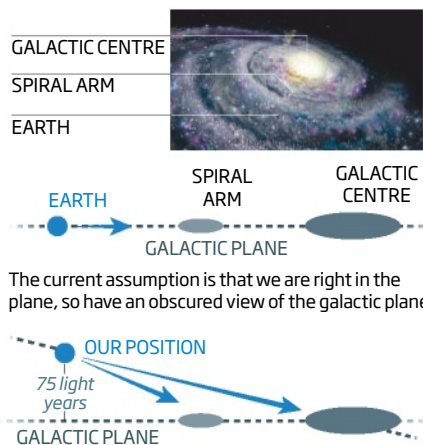
The effect of gravity in a disc-shaped galaxy like the Milky Way is to compress almost everything of interest into the central plane. From the symmetry of the Milky Way in the sky, there's good reason to believe that we are in that plane ourselves (see "Bright lights, big city", page 33). That's certainly been the official position since the 1950s: according to the International Astronomical Union's definition of the galactic plane, the sun lies directly within it. Ours is a frustrating ground-floor view of the galaxy.

In the past decade or so, though, studies using the ammonia emissions of dense, star-forming regions to assess their distance from us have suggested a different picture. The true galactic plane seems to be several light years lower than the IAU definition, with the sun 75 light years above it. The galactic centre is also about 20 light years lower than previously thought, placing the galaxy at a slight tilt relative to the sun's position (see "Penthouse view", below).

It's a small effect in a galaxy 1000 light years from top to bottom, but it makes all the difference. Rather than looking out of a ground-floor window at the galactic city, we may have a slightly elevated view of that crucial central plane from a few tens of storeys up.

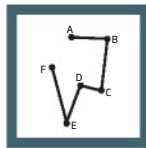
Penthouse view

Most objects of interest in the Milky Way lie in or around the galactic plane - making our position relative to it crucial



The current assumption is that we are right in the plane, so have an obscured view of the galactic plane

New observations suggest we are actually slightly above the galactic plane - giving us a much better vantage point



What's where?

Observations of the Milky Way strip and our interactions with our galactic neighbours give us a reasonable idea of our galaxy's outward appearance and size. But how do we find out what's where within it? It's not easy: the night sky is a 2D projection of a 3D picture, with little indication of how far away different objects are.

To get round this, astronomers turn to hydrogen, the most abundant element in the cosmos, accounting for 90 per cent of its non-dark-matter mass. Much of it lurks as vast, diffuse, faintly glowing clouds of neutral gas in the frigid space between stars.

The glow comes from photons emitted when slightly energised hydrogen atoms return to their natural, lowest energy. Sent out with a radio wavelength of 21 centimetres, this radiation isn't visible to the naked eye, but unlike visible light it can pass through dust and so make its way to Earth.

It's here that the Doppler effect kicks in.

This effect, heard in the swooping tone of an ambulance siren as it passes us, describes how radiation is squeezed or stretched in wavelength depending on whether its source is moving towards or away from us.

In the galactic whirl, hydrogen clouds in different places will be moving at different speeds and in different directions relative to us. By measuring how the light we receive from them is shifted away from its nominal 21-centimetre wavelength, we can build up a 3D picture of those motions. Comparing the Doppler shifts of other objects to this reference then allows us to work out where in the galaxy they must be (see "Galactic markers", below).

Hydrogen's abundance means it provides only a rough "big picture" of the galactic movements. Emissions from less prevalent gases such as carbon monoxide and ammonia can be used in a similar way to pinpoint individual structures more precisely.

Galactic markers

It can be hard to tell how far away things are from each other in the Milky Way. One way is to look at the light we receive from clouds of hydrogen gas scattered across the galaxy

HOW IT WORKS

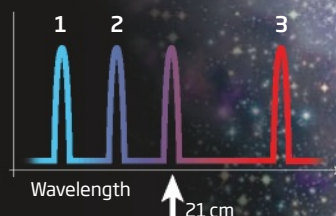
Neutral hydrogen naturally emits radiation at a wavelength of 21 centimetres. But this wavelength is either squashed or stretched depending on whether the cloud is moving towards or away from us - giving us a handle on its position in the galaxy

Motion towards

Squashed wavelength - blueshift

Motion away

Stretched wavelength - redshift



2. Slow movement towards us

1. Fast movement towards us

Rotation speed decreases with distance from galactic centre

OUR SOLAR SYSTEM



“Measurements confirm that the Milky Way’s mass is far greater than can be accounted for by visible matter”

Weighing the Milky Way

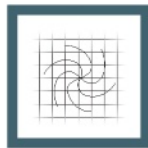
Our galactic neighbours can tell us something about how much stuff our galaxy must contain. Like all the nearby galaxies we see, the Milky Way is surrounded by a coterie of dwarf companions. The speed at which they circle depends on the size of the central mass that swings them round.

Measuring dwarf galaxy speeds confirms an effect seen in many other galaxies and clusters: the Milky Way’s mass is far greater than can be accounted for by visible matter. About 90 per cent seems to take the form of some inscrutable “dark” matter.

The earliest estimates suggested the Milky Way’s mass was about the same as, or perhaps even greater than, that of our

nearest neighbour Andromeda – a puzzling result, as the Milky Way doesn’t seem to have quite the number of dwarf satellites expected for that gravitational heft.

Last year, however, a new “big picture” analysis by Jorge Peñarrubia at the Royal Observatory in Edinburgh, UK, and his colleagues took into account motions within the Local Group of galaxies, the imaginatively named cluster containing the Milky Way, Andromeda and a few others. Its conclusion was that the Milky Way has perhaps only half the mass of its neighbour – although at around 800 billion suns, it is still no lightweight (*Monthly Notices of the Royal Astronomical Society*, vol 443, p 2204).



The Milky Way’s bones

Like radio emissions from neutral hydrogen, infrared radiation produced by the Milky Way’s warm stuff pierces our galaxy’s dusty fog. This has allowed instruments such as NASA’s infrared Spitzer Space Telescope to infer the existence of networks of filaments underlying and jutting between the star-rich spiral arms of other galaxies – a skeleton of star-forming “bones”. The bones themselves aren’t visible: they are so dense the infrared radiation can’t get through. But they are surrounded by a less dense “flesh” whose glow can be picked up.

Astronomers had long assumed that the Milky Way possessed similar structures, but until recently they had evaded detection, swamped in the galaxy’s general infrared noise. But with care, the backlighting provided by the galactic centre allows us to view the bones directly – as infrared-blocking silhouettes.

“Nessie” is one prominent example: a serpent-like dark cloud first discovered in 2010. It was initially thought to be 260 light years long by 1.5 light years wide, and contain material amounting to 100,000 suns. Last year, however, Alyssa Goodman of the Harvard-Smithsonian Center for Astrophysics found it was just part of a larger structure between two and five times as long (*The Astrophysical Journal*, vol 797, p 53).

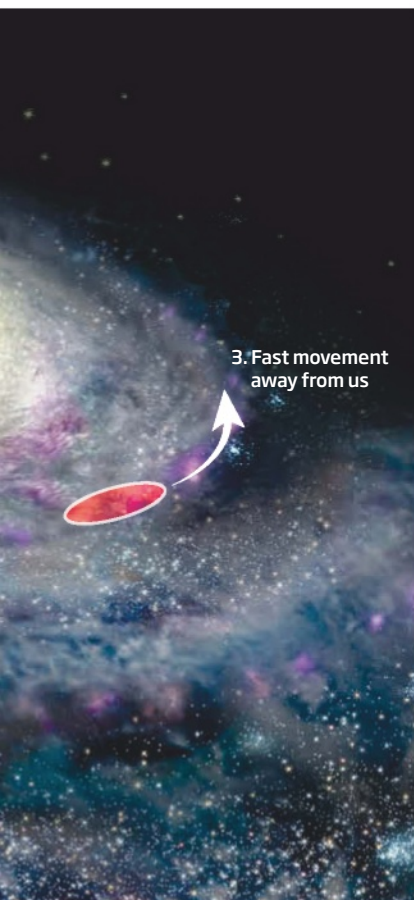
Mapping Nessie’s three-dimensional

position using latitude, longitude and velocity data from its carbon monoxide and ammonia emissions, and combining this with the redefined level of the galactic plane (see “Are we up or down?”, page 34), suggests it lies on the galactic plane about 10,000 light years from the sun. It also implies it lives on and right along the spine of the Scutum-Centaurus arm, the closest major spiral arm to the sun looking towards the galactic centre.

Such a long, filamentary structure would be expected to be extremely unstable and short-lived, suggesting Nessie is part of a much larger galaxy-scale structure. Even based on the most optimistic estimate of Nessie’s size, it accounts for just five-millionths of the non-dark-matter mass of the Milky Way. Thousands more Nessie-like features in the galactic plane could be waiting to be discovered.

From our newfound position overlooking the galactic plane, the next few years should allow us to unearth more and more of these bones of the Milky Way. At the same time, the European Space Agency’s Gaia mission, launched in 2013, will be mapping 1 billion of our galaxy’s brightest stars – making for an unprecedented view of our galactic home. ■

Ben Gilliland is a science writer and author of *How to Build a Universe* (Cassell, 2015)



PIKAIA IMAGING

Easy as pie

Forget fad diets, it is tiny tweaks that make the biggest changes to your eating habits, says psychologist **Brian Wansink**

IF I'VE learned one thing from my 25 years of research, it is this: when fighting the fat, and trying to eat healthily, changing your eating environment is easier than changing your mind. Through hundreds of secret studies, my team has set about uncovering the hidden persuaders around our homes that trick us into overeating – things like serving spoons, spouses, cupboards and colours. But most of these tempters (except maybe spouses) can also be reversed to make us slimmer and healthier.

Although there are many solutions to mindless eating, most of them will go undiscovered because if we go on a health kick, we tend to focus on food itself, not on our surroundings. We're often too focused on eating less of one thing, more of another, or sticking to gruelling fad diets and exercise regimes.

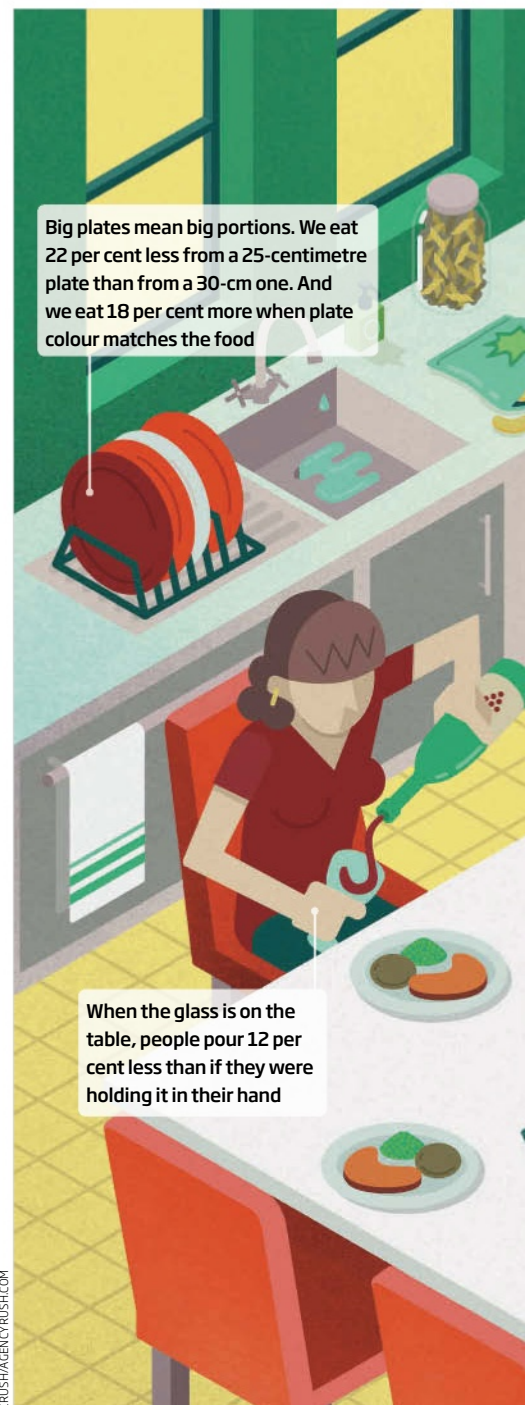
All that requires willpower, which is hard work and has to last a lifetime to be truly successful. But there's an easier solution. My latest research has found subtle ways to tweak our homes, workplaces, schools, restaurant dining and grocery shopping so we mindlessly eat less instead of more. If we want

to automatically eat better, we don't have to change our minds; we just have to optimise our surroundings.

Let's start at home. Seemingly irrelevant decisions can set you up for a fall. Take the colour of your plate. If it's the same colour as the food, you'll serve yourself more. We discovered this when we invited 60 people to a free pasta lunch at a summer alumni reunion at Cornell University in Ithaca, New York. We gave them either a red plate or a white plate and sent half the diners over to a red pasta buffet (marinara sauce) and the other half to a white pasta buffet (Alfredo sauce).

After they served themselves, we surreptitiously weighed their servings. Those who helped themselves to either white pasta on a white plate or red on red gave themselves 18 per cent more calories than those with plates that contrasted with their food. This is news you can use at home. And because white starches – pasta, rice and potatoes – are a big source of calories, using darker plates could be a smart strategy if you're looking to lose weight.

Plates are just the start. To find out what a healthier home looks like, my team visited



230 homes in Syracuse, New York – a small city demographically representative of the rest of the US. We weighed the inhabitants and took pictures of their kitchens – the layout, what was on their shelves and in their fridges, all the food that was out on the kitchen counters rather than in their cupboards. Nothing went unspotted. We then spent eight months classifying these kitchens to see what slim people do that influences their diets. We found that it's kitchen content, rather than size, that makes all the difference, and that women are more susceptible to the lures there than men.

Perhaps unsurprisingly, leaving food out on



the counter was a barometer for bad eating habits. The average woman who kept potato chips on the counter weighed 3.6 kilograms more than her neighbour who didn't. That makes perfect sense. These snacks are very tempting – you can't eat just one – and they can make you fat. But crisps aren't anywhere near the biggest culprit. That accolade fell to meek, whole-grain breakfast cereal in boxes covered with pictures of smiling, healthy women with gleaming teeth.

Women who had even one box of breakfast cereal that was visible – anywhere in their kitchen – weighed 9.5 kilograms more than

their neighbours who put the cereal out of sight. Cereal has what we call a health halo: the boxes are covered with health messages, so we underestimate the calories it contains and eat too much of the stuff. But having cereal on the counter had no impact on men, possibly because those products aren't marketed at them, or perhaps they simply spent less time in the kitchen.

If you're looking to shed some weight, putting away the snacks and cereal is no guarantee things will change overnight, but it might just tilt the scales in the right direction. Don't stop there though. We are often told that

sitting down to a meal at the dinner table, rather than mindlessly eating in front of the TV, is a good way to eat less and better. But it's not that simple.

Some families serve meals by crowding all their serving dishes onto the table, other families serve food off the stove or counter. We found that families in the second category ate 19 per cent less in total compared with those serving themselves at the table. It seems that when the food is in easy reach

"People sitting farthest from the door were 73 per cent more likely to order dessert"

we mindlessly serve ourselves more, whereas having to get up and walk a few paces was enough for people to ask themselves if they really were still hungry. The answer is usually "nope". Although, if you want to eat more greens, plant that salad bowl right in the middle of the table.

Food is not the only enemy when it comes to overindulgence, as many of us know too well at this time of year. So if you love wine, but hate headaches, here's how to automatically drink about 10 per cent less. We brought 85 wine drinkers into our lab for happy hour, gave them different glasses and made them either sit or stand. We found that people tend to focus on the height of what they pour and not the width, so we pour 12 per cent less wine into taller glasses than if we use wider wine glasses that hold the same amount.

Plus, looking down at a glass makes it appear more full than looking at it from roughly the same level as the liquid. As a result, we're likely to pour 12 per cent less into a glass that's sitting on the table compared with one we're holding.

Just as with the plates we use, contrast also has an effect. Because red wine is easier to see than white wine, we pour about 9 per cent less red wine into whatever glass we're using.

But it's not just wine glasses. One winter we visited 86 Philadelphia bartenders and asked them to pour out the amount of alcohol they would use to make a gin and tonic, a whisky on the rocks, a rum and coke, and a vodka tonic. Whether they had worked there for 32 minutes or 32 years, the typical bartender poured 32 per cent more alcohol into short, wide tumblers than into highball glasses of the same volume. They focused on the height of the liquid and not the width.

The bartenders were shocked when we showed them how much they had over-



poured. Yet strikingly, even when we asked them to pour again 2 minutes later we saw the same result. This highlights another point we consistently find with our research. Don't think that being aware of these pitfalls will make you avoid them – it won't. In the chaos of daily life, our automatic behaviours mindlessly fall back into the same mistakes we've always made. Instead, you have to take steps to avoid the traps.

For my book, *Slim by Design*, my team and I devised a scorecard that includes the 100 easiest home-related tips. Try the shorter version of this quiz (see "Health check your home", below right) to see how well your kitchen fares.

One benefit of the scorecard is that it usually shows progress each time you fill it out. It can give you a tangible measure that you're doing the right things.

Reorganising your home is the first part. But what if you undo all that good work when you go out to eat? The first moments you spend in a restaurant could set you up for a fall, because where you sit might influence what you order.

We recently visited 27 restaurants across the country, and measured and mapped the layout of each one. We knew how far each table or booth was from the windows and front door, whether it was in a secluded or well-travelled area, how light or dark it was and how far it was from the kitchen, bar, toilets and TV sets. After diners began arriving, we were able to track what they ordered and how it related to where they sat. In one restaurant in particular we collected every single receipt, every day, for three months.

Window of opportunity

So are there unhealthy tables in restaurants? This is preliminary, but so far it looks like people ordered healthier foods if they sat by a window or in a well-lit part of the restaurant. It seems that they ate fattier, calorie-laden food and ordered more of it if they sat at a dark table or booth. People sitting farthest from the front door ate the fewest salads and were 73 per cent more likely to order dessert. A table of four sitting within two tables of the bar drank an average of three more beers or alcoholic drinks with a mixer than those sitting just one table farther away. The closer a table was to a TV screen, the more fried food a person bought and people sitting at high-top bar tables ordered more salads and fewer desserts.

Some of this makes sense. The darker it is, the more "invisible" and therefore less

A dish described as "crispy" on a menu will have, on average, 131 more calories than a non-crispy version. Add 102 cals for "buttery", but deduct 60 for "roasted"

Diners near the window order more side salads and fewer drinks

People sitting close to the bar drink more than those farther away

People who sit tucked away in a cosy corner booth tend to tuck into more desserts

HEALTH CHECK YOUR HOME

Does your kitchen design encourage you to avoid mindless eating? Answer the following questions to find out. Each tick counts as a point. If you get seven or more, you're on the right track.

- ☐ Do you serve salad or vegetables before the main meal?
- ☐ Do you put the main course on plates at the stove or counter rather than at the table?
- ☐ Are your dinner plates no more than 22-25 centimetres across?
- ☐ Do you eat sitting at a table with the TV off?
- ☐ Are there no more than two cans of soft drink in your fridge at a time?
- ☐ Are your kitchen counters organised and clean?
- ☐ Do you pre-prepare fruit and vegetables and keep them on your middle refrigerator shelf, where they are easily seen?
- ☐ Are there at least six servings of protein in your fridge (eggs, yogurt, tofu, etc.)?
- ☐ Do you keep your snacks in one inconveniently placed cupboard?
- ☐ Is fruit the only food on your kitchen counter?

conspicuous or guilty you might feel, and the harder it is to see how much you're eating. Seeing the sunlight, people or trees outside might make you more conscious about how you look, make you think about walking or prime you for a green salad.

Equally, sitting next to the bar might make you think it's more normal to order that second drink, and watching TV might distract you from thinking twice about what you order.

If tall tables make it harder to slouch or spread out, they might cause you to feel more in control and to order in the same way.

Does sitting in a dark, quiet booth in the back of the restaurant make you order more dessert? Not necessarily. It might be that dessert-eaters naturally gravitate to those tables, or that a waiter takes them there out of habit.

We have an expression in our lab: "If you want to be skinny, do what skinny people do." Either well-lit, elevated tables near windows make you eat better, or people who eat better like to eat at well-lit, elevated tables near windows. But while you're contemplating the causality, the couple next to you just took the last high table by the window. ■

Brian Wansink is director of the Cornell University Food and Brand Lab in Ithaca, New York. His latest book, *Slim by Design*, is published by William Morrow



ROD WILLIAMS/NATUREPL.COM

Join the conversation

New ways to decode animal chatter reveal a lot about what they are saying, says Hal Hodson

IN RACINE Zoo, Wisconsin, the white-handed gibbons are gearing up for something. One woman watching them knows what that might be. Angela Dassow is staring at them from behind her sunglasses, listening to their every oo and ah. Suddenly she perks up, seemingly knowing that something is about to happen. Sure enough, the female gets going on her morning territorial song, a haunting melody that builds to a crescendo before finally settling on a melancholy ooo.

Dassow, a zoologist at Wisconsin University in Madison, could do something similar for any gibbon on the planet because, to a certain extent,

she knows what they're saying. After hours of practice over several years she can not only recognise every call type but also knows that the sounds and how the gibbons link them together amount to much more than a series of primitive calls. Her colleague, computer scientist Michael Coen, has written algorithms that recognise this too. Together they have found subtleties in gibbon songs that, while not language as we would know it, are more than mere noise.

There is more to this than just deciphering what gibbons are whooping on about. Dassow and Coen think we have underestimated animal



SING IT TO SAY IT

Complex human language didn't just pop up out of nowhere. Like everything else it must have evolved from an intermediate stage. But trying to pin down what that might have involved is difficult, not least because communication among our closest relatives, the great apes, isn't particularly impressive. Great apes do little more than give different calls for different foods and perhaps a generic warning of a predator nearby.

Gibbons are considered "lesser" apes, one step further away from us on the evolutionary tree, but in terms of communicating they go several steps beyond our closest cousins, using structured songs to convey different pieces of information. Some researchers,

including Esther Clarke, an evolutionary anthropologist at Durham University in the UK, think that human song was a precursor to spoken language, and that gibbon song today sounds a lot like the songs early humans used to communicate 1.8 million years ago.

Clarke says that singing uses all parts of the vocal tract, so might have helped us develop the vocal skills that led to speech.

And since gibbon song seems to have evolved to be a general-purpose tool for communication, it could explain how we became masters of communication ourselves. Why the great apes chose grunting over singing, however, is likely to remain a mystery.

communication. They think many animals interact in much more sophisticated ways than we have given them credit for. As well as gibbons, they are studying rats, dolphins and many other species. They think that they can construct a kind of Rosetta Stone of animal communication, because some animals not only have sounds for specific things, such as food, but also build these into sentences with rudimentary grammatical rules. If Dassow and Coen create a decoder, we might not only be able to decipher what animals are saying, but maybe even talk back. It could also give a new perspective on the long-running mystery of where our own language skills came from.

The meanings hidden in gibbon song first gained attention in 2006. Esther Clarke, then at the University of St Andrews, UK, recorded the calls of wild, white-handed gibbons in Khao Yai National Park in Thailand while sneaking fake clouded leopards, tigers or snakes into their territory. While gorillas and chimpanzees communicate using grunts and other distinct noises, gibbons use continuous strings of sounds much more akin to singing. They are the only apes to do this, and Clarke wondered if their songs might be providing specific information. Sure enough, Clarke and her team found that they used seven basic sounds, which she described as: "wa", "hoo", "leaning wa", "oo", "sharp wow", "wao" and "other" (see illustration, page 41). Males and females use these sounds as part of their morning territorial duet, which bonds pairs

and stamps their claim on a patch of forest. But they are also able to combine these in different ways to pass on warnings of specific predators to the group, such as "clouded leopard" or "snake" (*PLoS One*, vol 1, p e103).

Howling wolf

At the time, Coen was working on an algorithm to break down zebra finch song into its component parts. Most analyses of animal calls use a visual representation of the frequencies of the sound, but Coen's was different. His system measured subtle variations in frequency from the beginning of a call to the end. These differences would be invisible on standard sound traces and inaudible to the human ear but when run through Coen's software, small differences in two very similar-sounding "waaas" look very different. Coen heard about Clarke's work and wondered if his algorithm could get even more from her gibbon songs. Then he met Dassow, then a graduate student with a rare talent for howling like a wolf. Working for the Wisconsin Department of Natural Resources, her job was to howl into the darkness, and then note down the number, sex and age of the wolves that replied. Coen was intrigued. "She was so sensitive to the wolves' vocalisations that she could identify them individually based on sound. When I heard that, I wanted her on board," he says.

Before she could help, though, Dassow had

to get her ear in, which she did using her own unique, and somewhat time-consuming, method. "When working with a new species that I'm unfamiliar with, my process is to literally listen to their recordings day and night," she says. "I just need to sit and listen long enough that I have a natural understanding of the sounds, of what is repeated." So she sat, for 4 or 5 hours at a time, headphones clamped over her ears, listening to the recordings from Clarke's 13 gibbon groups over and over again. Finally, after about a year of immersion, the gibbons' songs started to make sense.

Meanwhile, Coen was adapting his zebra finch algorithm to do something similar. When he ran gibbon sounds through it, he found that many calls that sound identical to our ears and look the same on the standard sound graph are in fact very different. "In spectrograms all the oos look the same," Coen says. "With the algorithm they are all wildly distinct. You would never confuse them."

Dassow's sensitive ears and Coen's algorithm found the same breakdown of basic units across the gibbon calls. Coen's algorithm hears 25, while Dassow hears 26, saying that one sound has an "s" and "t" variation that the algorithm fails to pick up. That's an extra 19 call types on top of Clarke's seven.

So what else is being said in the trees? Dassow and Coen think the gibbons are doing more than simply pointing out predators to each other. They already had a handle on the gibbon





GREGORY SHAWER/JOURNAL TIMES, RACINE, WISCONSIN



NCS



IAN NICHOLS/NATIONAL GEOGRAPHIC CREATIVE

“Dolphins have repeated back a new whistle invented by humans”

Analysing the calls of different species could uncover common elements to all of them

word for clouded leopard (see below) from Clarke's work, but now they knew there was more to it. “If the predator is stationary there's an extra ‘adjective’ afterwards,” says Coen.

Gibbon groups are led by alpha females, and Dassow and Coen noticed that one of the group leaders had more to say for herself than any of the others. This female used an extra eight acoustic units that no other gibbon used. They are not sure yet what she is saying, but one possibility is that she is giving specific instructions to the rest of the group. “A male may be saying, ‘We're being attacked,’ but the females are the alphas, so maybe they're the ones giving instruction on what to do,” suggests Coen. Perhaps, for example, the female's call includes advice on how to get out of danger. If they are low in the canopy when a predator approaches, for instance, the song might say “clouded leopard, climb higher”.

Dassow and Coen are now planning to do fieldwork in Thailand to help them better understand these sounds. They have also started studying what other animals are saying. They have found 29 types of rat calls, compared with the previously known three. They don't know what these extra calls mean yet but the more calls that are analysed, the greater the chance of finding common structure to a range of animal calls.

Other researchers are attacking the same question in a slightly different way, using algorithms to work out how sounds are structured into a meaningful sequence.

Brenda McCowan at the University of California, Los Angeles, is part of a team that is analysing sequences of dolphin whistles. They say they have found patterns that are similar to human grammatical rules. “These kinds of approaches will help us understand where we might find higher meaning in animal communication,” says McCowan.

And once we know what they are saying, might we be able to talk back? There are

How to talk gibbon

Researchers studying gibbon language have started to relate common sounds they make to specific situations

“wao-hoo-hoo-hoo-wa-wa”

Clouded leopard!



“wao-hoo-hoo-hoo-hoo-hoo”

Snake!



“waa-hoo-wa-waa-wa-wa”

I'm a male gibbon and I'm with her



“wa-waa-wao-hoo-waa-hoo”

I'm a female gibbon and I'm with him

intriguing signs that such a thing might be possible. Last year Denise Herzing of the Wild Dolphin Project in Florida and her team introduced a “word” to wild dolphins. They did this by inventing a new whistle and using it repeatedly whenever they held onto a certain type of seaweed. Soon afterwards one of the dolphins spontaneously used the call back to them. It only happened once, so it probably doesn't count as an interspecies language just yet, but we're getting closer.

Coen, too, has programmed a piano keyboard to play different components of gibbon song back to them. However, since he and Dassow have only worked on predator calls so far, they have avoided using it for now. The worst that could happen would be that the gibbons might learn to ignore the keyboard, scuppering future attempts at conversation.

The ultimate animal translator is probably a long way off, but these new approaches mean that we can finally study animal communication on its own terms, rather than assessing their understanding of human language. At any rate, the dividing line between language and communication is too harsh, Coen says. “There's probably some spectrum here.”

As we work on translating what animals are saying to each other, it might be time to think about what we would like to say to them. And whether we will like what they say in return. ■

Hal Hodson is a technology reporter at *New Scientist*

One per cent inspiration...

Are we any closer to finding the wellspring of creativity and innovation?

Justin Mullins goes in search of answers

Eureka! Discovering your inner scientist by Chad Orzel, Basic Books, \$17.99

How to Fly a Horse: The secret history of creation, invention and discovery by Kevin Ashton, William Heinemann, £20

Spare Parts: Four undocumented teenagers, one ugly robot, and the battle for the American dream by Joshua Davis, FSG Originals, \$14

THE secrets of invention and creativity have long puzzled, eluded and fascinated in equal measure. Many scientists, inventors and artists seem to have understood them intuitively, yet few have written coherently and knowledgeably about the details.

In *Eureka! Discovering your inner scientist*, Chad Orzel entertainingly argues that we are all scientists, with the innate ability to discover and create. And by exploring the work of great scientists he shows how it is done.

For example, the American physicist Luis Alvarez is widely regarded as one of the most brilliant and creative of the 20th century, not least because of his impact on disciplines beyond his own. Early in his career, Alvarez settled a long-standing argument among astronomers about the nature of cosmic rays: were they photons of high-energy light or charged particles?

He solved this conundrum by inventing a cosmic ray telescope that could determine the direction of the particles. Then he showed that the particles were deflected by Earth's magnetic field and so must be positively charged.

The four unlikely roboticists whose story is told in *Spare Parts*

Alvarez was able to apply cosmic ray telescopes and what he learned from them widely. He used a similar telescope to show that the Pyramid of Khafre in Giza, Egypt had no hidden chambers. And he also proved that the layer of clay laid down 65 million years ago between the Cretaceous and the Tertiary eras contained iridium that must have had an extra-terrestrial origin, most likely from an asteroid impact.

Orzel argues that while Alvarez was brilliant, his productivity did not come from a scattergun approach to science. Instead, he applied a relatively small set of techniques to a wide range of

areas. For Orzel, it is the ability to look at and think about different parts of the world in the same way and then test ideas about them that defines scientific creativity.

Further, he believes that we all do this. When we cook, play chess, tell stories and so on, the results of these activities are essentially the scientific process in action. Recognising this everyday aspect gives us a better insight into the nature of creativity.

The story deepens in *How To*

"When we cook, play chess, tell stories, the results of these activities are the scientific process in action"

Fly A Horse: The secret history of creation, invention and discovery by Kevin Ashton. He has some personal experience as an inventor, entrepreneur and a pioneer of the next generation of computing (he coined the term "the internet of things").

Ashton writes that the process of creativity extends far beyond the individual who finds him or herself at the end of it. It is, rather, a continual process of building in which each step depends crucially on those that went before. The final step in this process is sometimes important but often incidental, claimed by many, or forgotten.



LIVIA CORONA

In this vision, the idea of the born genius is anathema. And Ashton rejects the notion that there are a handful of Mozarts, Picassos and Einsteins in every generation, hard-wired with unmatched creativity.

Instead, he shows that being at the end of a long chain of events is the result of hard work, independent thinking and more than a little luck. That's not to diminish the process of creativity and invention. Often, that final step is hard to make and requires an extraordinary individual to take the leap, many of which he describes in fascinating detail.

Ashton covers a lot of ground in *How to Fly a Horse*, revisiting well-known stories but through his own prism of creativity. The result is an engaging, fast-moving read that compels and surprises.

Another myth about creativity and invention is that it is most likely to be found among the wealthy white middle classes. That is an image Joshua Davis sets out to smash in *Spare Parts: Four undocumented teenagers, one ugly robot, and the battle for the American dream*. It's the true story of four Mexican-American high-school kids who live in a run-down suburb of Phoenix, Arizona, with barely a legal immigration document between them.

In 2004, they represented their school in a NASA-sponsored underwater robotics competition, taking on schools and colleges from all over the US, including a team from the Massachusetts Institute of Technology sponsored by ExxonMobil. Their story shows the importance of hard work, invention and inspiration in equal parts, and still manages a kick in the tail.

Davis first reported on this in *Wired* magazine in 2005, and the book-length version will coincide with the release in January of a movie based on the story. It's the American dream in action. ■

Justin Mullins is a consultant for *New Scientist*

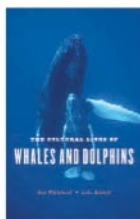


BRANDON COLE/NATUREPL.COM

Whaleworld

Orca clan calls and dolphin tail-walking may point to cetacean culture, says **Bob Holmes**

The Cultural Lives of Whales and Dolphins by Hal Whitehead and Luke Rendell, University of Chicago Press, \$35.00



EVERYONE knows that whales and (possibly) dolphins are smart. Sperm whales have the largest brains on the planet and, relative to body size, the brains of dolphins are second only to humans. But have they taken the next step and used this brainpower to pass important knowledge from generation to generation? That is, have they developed culture?

In *The Cultural Lives of Whales and Dolphins*, Hal Whitehead and Luke Rendell, two of the world's leading cetacean biologists, make the case for cetacean culture. In fact, they suggest that for tens of millions of years – until the rise of modern humans – the most sophisticated cultures on Earth

were those of whales.

Asserting that any animal other than humans has culture is fraught with controversy, so Whitehead and Rendell spend a big chunk of their book defining the term “culture”: essentially, information or behaviour acquired through social learning. This is important background, but most readers will find it dry and technical. Fortunately, we soon get to the whales, with plenty of biological detail setting out the evidence for whale culture.

“Until modern humans, the most sophisticated cultures on Earth were those of whales”

In a few cases, this evidence seems indisputable: humpback whales sing similar songs throughout entire ocean basins, and these songs change gradually during the lifespan of individuals. The only way that can happen is if individual whales listen to and

Does the feeding behaviour of humpback whales show culture?

learn from one another. Orca clans each have distinct calls that serve, essentially, as ethnic markers, even though the genetic differences between the clans are negligible. Sperm whales have vocal clans, too, that span whole ocean basins. Cultural learning must be involved. And there are a few cases, such as “tail-walking” in dolphins and a peculiar sort of feeding motion in humpback whales, where biologists have actually seen the behaviour spread between individuals.

More often, though, the case for culture is a little murkier. Take, for example, the dolphins in Shark Bay, Western Australia, who carry sponges on their snouts while bottom-feeding. This probably protects them from sharp-spined fish, but only a few family units within the bay do it. This looks a lot like culture passed down from mother to daughter, but it could also plausibly be the result of specific environmental conditions or of genetic endowments. It's not easy for land-bound biologists to be sure.

It's even harder to know how important culture has been in shaping the ecology, evolution and environment of whales and dolphins. But that doesn't stop the authors speculating that culture may be why orcas and sperm whales are successful top predators, and the most geographically widespread animals on Earth, except for humans. And if culture is as important to whales as it appears, then conservationists will need to protect not just their genetic diversity but their cultural diversity as well.

All this speculation is underlain by a wealth of biological detail, all carefully annotated, making this book a valuable – and usually very readable – resource for anyone interested in cetacean behaviour. ■

Bob Holmes is a consultant for *New Scientist*


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Applications are invited for 1 or more tenured/tenure-track faculty positions at the Institute for Quantum Computing (IQC) and any department in the Faculties of Engineering, Mathematics and Science. The IQC is a collaborative research institute focused on realizing quantum technologies including sensors, actuators, quantum communication, and information processors. Membership in IQC is renewable, with an initial appointment of 5 years, and comes with research space, a teaching reduction of one course and a stipend. Only those candidates whose research program directly connects with the goals and ongoing research in IQC will be considered. Information about research at IQC can be found at <http://uwaterloo.ca/iqc/research>

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Jackson School of Geosciences
The University of Texas at Austin
2305 Speedway, Stop C1160
Austin, TX 78712-1692

For more information, please visit
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The Wadsworth Center (Albany, NY) is seeking an outstanding scientist to join its Public Health Genomics Center. The successful applicant will be responsible for the development and implementation of next-generation sequencing and associated bioinformatics analyses in the research and public health programs of the Center. He or she will collaborate with research scientists to develop cutting-edge approaches for applications such as, pathogen identification, outbreak tracking, mapping drug-resistance determinants and novel genetic testing. In addition, there will be opportunities to participate in the various educational activities offered by the Wadsworth Center.

The Wadsworth Center (www.wadsworth.org) is the country's most comprehensive state public health laboratory with a staff of about 750. The Center provides a dynamic research environment focused on infectious, genetic and environmental diseases and their impact on human health. Through its initiative for Public Health Genomics, the Center will bring NGS and other advanced molecular technologies to public health testing, diagnosis, and research, further develop these technologies to address new and emerging challenges, and become a regional center of excellence for NGS in the area of public health genomics.

Ph.D. degree or equivalent and one to two years of relevant postdoctoral research preferred. Experience with various approaches for sample preparation for sequencing of microbial specimens and applications of different sequencing strategies is desired. Applicants should submit a cover letter, curriculum vitae, and contact information for at least three references to wcphgc@health.ny.gov, referencing posting RS3/4/12137. Applications will be accepted until the position is filled and reviewed as they are received. AA/EOE.

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GROWING IANR

Faculty Positions

Institute of Agriculture and Natural Resources
The University of Nebraska-Lincoln

The Institute of Agriculture and Natural Resources (IANR) at the University of Nebraska-Lincoln (UNL) is committed to world-class excellence in applications of agricultural and life sciences towards a sustained high quality of life for the citizens of Nebraska, and for a quickly growing global population. Early in 2013, reflecting this commitment, IANR launched an initiative to hire new tenure-track faculty members in strategic impact areas of Science Literacy; Stress Biology of Plants, Animals, and Agroecosystems; Healthy Humans; Healthy Systems for Agricultural Production and Natural Resources; and Computational Sciences. This Phase 1 effort was very successful, resulting in the recruitment and hiring of 35 highly skilled tenure-line faculty members (with two searches still active).

We are pleased to announce Phase 2 of this effort with recruitment for an anticipated 30+ additional tenure-line faculty positions. The focus for Phase 2 will be to strengthen the six strategic impact areas in Phase 1, with an additional focus area – Drivers of Economic Vitality for Nebraska.

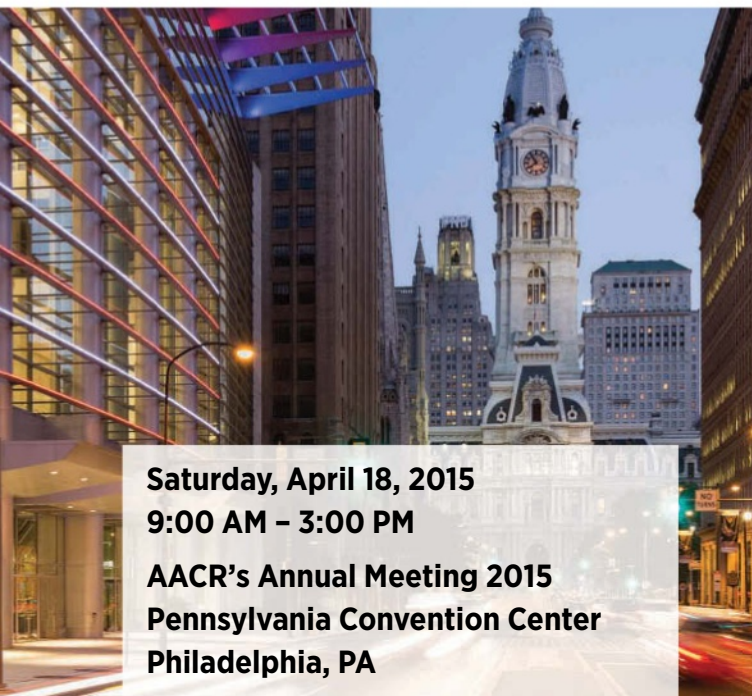
We invite you to view brief explanations of the positions currently being released and those to be released soon at <http://ianr.unl.edu> to explore whether your skills and experience make you a good fit for our team.

The positions will be advertised and posted beginning December 1, 2014. We invite you to visit the UNL employment web site at <http://employment.unl.edu> to learn which positions are posted.

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Grant Programs

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Collaborative Research Travel Grants:

Provide up to \$15,000 in support for interdisciplinary biomedical researchers from degree-granting institutions to travel to a laboratory to acquire a new research technique or to facilitate collaboration.

DIVERSITY IN SCIENCE

Postdoctoral Enrichment Program: Provides \$50,000 over three years to support the development of underrepresented minority postdoctoral fellows in biomedical research.

INFECTIOUS DISEASES

Investigators in the Pathogenesis of

Infectious Disease: Five-year awards provide \$500,000 for opportunities for accomplished investigators at the assistant professor level to study infectious disease pathogenesis, with a focus on the intersection of human and microbial biology. The program is intended to shed light on the overarching issues of how human hosts handle infectious challenge.

INTERFACES IN SCIENCE

Career Awards at the Scientific Interface:

Five-year awards provide \$500,000 to bridge advanced postdoctoral training and the early years of faculty service. These awards are intended to foster the early career development of researchers with backgrounds in the physical/mathematical/computational/engineering sciences whose work addresses biological questions. BWF has moved to a self-nomination format for this award.

POPULATION AND LABORATORY BASED SCIENCES

Institutional Program Unifying Population and Laboratory Based Sciences:

Five-year awards provide \$2.5 million to unite population-level and laboratory-based biological sciences. The award supports the training of researchers working between existing research concentrations in population approaches to health and in basic biological sciences. The goal is to establish interdisciplinary training programs by partnering researchers working in disparate environments and intellectual frameworks.

REGULATORY SCIENCE

Innovation in Regulatory Science Awards:

Provides up to \$500,000 over five years to academic investigators who are addressing research questions that will lead to innovation in regulatory science, with ultimate translation of those results into improving the regulatory process. These awards are intended to provide support for academic researchers developing new methodologies or innovative approaches in regulatory science that will ultimately inform the regulatory decisions the Food and Drug Administration (FDA) and others make.

REPRODUCTIVE SCIENCE

Preterm Birth Initiative: Provides \$600,000 over a four-year period to bring together a diverse interdisciplinary group with the more traditional areas of parturition research to address the scientific issues related to preterm birth.



SCIENCE EDUCATION

Career Awards for Science and Mathematics

Teachers: Five-year awards provide \$175,000 to eligible science or mathematics teachers in the North Carolina public primary and secondary schools. The purpose of this award is to recognize teachers who have demonstrated solid knowledge of science or mathematics content and have outstanding performance records in educating children. The award is a partnership between the North Carolina State Board of Education and BWF.

Student Science Enrichment Program:

Three-year awards provide up to \$180,000 to North Carolina nonprofit organizations, including public/private schools, universities, colleges, and museums. This program supports creative inquiry-based science enrichment activities that occur outside the typical school day for K-12 students. The program's goals are to nurture students' enthusiasm about science, expose them to the excitement of scientific discovery, and interest them in pursuing careers in research or a variety of other careers in science.

Promoting Innovation in Science and

Mathematics: Awards provide teachers with funding for materials, equipment, and training to conduct hands-on, inquiry-based science and mathematics projects in North Carolina public schools.

The Burroughs Wellcome Fund is a private foundation located in Research Triangle Park, North Carolina. Find out more at bwfund.org

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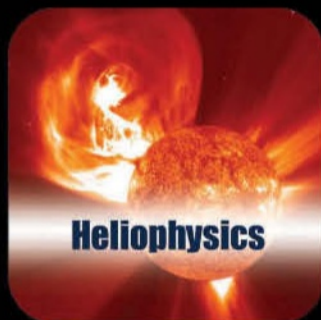
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Viral menace

From Richard Pearson
Hacking viruses to fight cancer cells sounds like a great idea (13 December 2014, p 28). But what happens when these synthetic viruses, to which we humans have presumably evolved no immunity, escape into the environment? Could a viral cancer cure, individualised to one person's needs, become a killer or a cause of illness in others when it escapes into the wild?

The interview with Andrew Hessel gave no consideration to these matters, merely stating that "regulatory concerns are the last of your worries" in compassionate use. In responsible medical science, shouldn't the potential for negative impacts and collateral damage beyond the patient be considered?

The eventual availability of small-scale "dollar a dose" virus printing equipment raises the prospect of putting production of bioweapons into the hands of those who would use it against humanity. Time for a rethink? *Bristol, UK*

The editor writes:

■ There are good questions around safety, to which we do not yet have answers. On the subject of malicious use, Hessel says: "People worry about the hacking of digital technology to make viruses that could be dangerous. But I am not inventing any of these tools; they are all here today and accessible. It's about time we started using them in productive ways."

The very first crypt

From Liz Bell
I was struck by Catherine Brahic's report of the fabulous find of early hominin fossils in the Rising Star cave system in South Africa (29 November 2014, p 40). This could perhaps be the most important

archaeological site yet found.

If the chamber is as remote and inaccessible as she describes, and is knee-deep in bones without evidence of occupation or them having been dragged there by predators, is it possible that the many skeletons were placed there



deliberately by the deceased hominins' relatives and friends? Could this be the earliest tomb yet discovered?

If so, do we need to rethink the cultural life of some of our remotest ancestors? *Hungerford, Berkshire, UK*

Only if reversible

From Hilary Gee
Regarding schemes to combat global warming by large-scale geoengineering projects, not only is there the vexed matter of who decides which should be tried (20/27 December 2014, p 43) but, even if this can be agreed, there is the small matter of getting it right first time.

Surely the key property of any such scheme is that it should be reversible. We are already well into one accidental geohack – burning fossil fuels to raise the global temperature – and that seems pretty hard to stop or reverse.

But even if we had the means to pause or reverse a geoengineering project, what makes anyone think it will be any easier to apply these than to do so for global warming? There will be huge financial,

industrial and political interests vested in the effort by the time we realise we got it wrong.

There is no planet B!
Cartmel, Cumbria, UK

Problem spelled out

From Quentin Macilray
Aviva Rutkin writes that by the age of 3 children from affluent families have heard some 30 million more words than their impoverished counterparts (29 November 2014, p 14).

The article goes on to discuss the consequences of this disadvantage in terms of brain development. But has anyone thought to ask how and why this relative deprivation occurs in the first place?

The article seems to take such a state of affairs as a given. But if it is as serious a disadvantage as the article suggests, surely the root cause needs to be addressed, not merely responding to the consequences on a post-hoc basis? *Limassol, Cyprus*

Cosmic coincidence

From Mick Crisford
I am less than impressed by the table titled "Symmetries of 37" in Christopher Kemp's article on the putatively portent number (20/27 December 2014, p 61).

The pattern is a by-product of 10 being our chosen base for counting. The base itself is arbitrary rather than inevitable, and has probably arisen because of the number of digits attached to our hands. It hardly represents evidence for a message sent by extraterrestrial intelligence before we evolved.

Burwash, East Sussex, UK

Sprucing up the US

From Craig Sams
Fred Pearce describes Chinese efforts to hold back the Gobi and

Taklamakan deserts through tree planting (13 December 2014, p 13). This mirrors work in the US during the 1930s to construct the Great Plains Shelterbelt, a 160-kilometre-wide swathe of 220 million trees stretching from Canada to Texas.

The work was carried out by the Civilian Conservation Corps, a work relief programme that employed 300,000 men annually. The Shelterbelt was intended to help control the Dust Bowl by reducing soil erosion.

The clouds of dust that turned midday skies dark as far away as Washington DC became a thing of the past.

Hastings, East Sussex, UK

When men conspire

From Derek Smith
Eric Oliver and Tom Wood discuss people's willingness to accept conspiracy theories (20/27 December 2014, p 36). In my experience, people find it easy to overlook them too.

I was a law instructor for a UK police force in the late 1980s. Someone in my department mentioned that Cyril Smith, then



the member of parliament for Rochdale, had many offences of gross indecency with children on file. Even after I did some of my own research I still doubted the information, as covering it up would have required a conspiracy between the police Special

Branch, the Security Service, senior lawyers and members of parliament. This seemed farcical.

Allegations of a child abuse ring involving British MPs have now come to light, as has testimony that investigators were prevented from bringing cases against Smith. Perhaps the question for Oliver and Wood should be: why did so few people believe this conspiracy theory at the time, and why did I and others dismiss it so easily?

Burgess Hill, West Sussex, UK

From Faith Anstey

Is belief in conspiracy theories due solely to human psychology and emotional reassurance, as Oliver and Wood say? They report more than half of people in the US believing in conspiracies. What are the comparable statistics for Europeans? It seems to me that many in the US believe in irrational things, such as creationism and alien abduction.

Might there be some cause specific to US culture – perhaps a “better safe than sorry” outlook? In an enormously powerful yet relatively young and insecure nation, might it seem safer to hedge your bets and believe in things that may not be true, rather than not to believe in something that – if it turned out to be true after all – could spell total disaster, such as alien conquest or the wrath of God?

Dalguise, Perthshire, UK

From Stephanie Trotter

I agree with Oliver and Wood that “The brain did not evolve to process information about industrial economies, terrorism or medicine, but about survival in the wild. This includes a tendency to assume that unseen predators are lurking or that coincidental events are somehow related.”

I have, however, also noticed an assumption by intellectuals, cognoscenti – and also by those who can’t be bothered – that anyone who raises an issue such as institutional racism in the

police, widespread child abuse by the church, or a cover-up after an event like the Hillsborough football stadium disaster, is mad and not to be believed. This isn’t helpful either.

What has been shown by recent events is that concerns should neither be believed automatically nor be brushed aside as a conspiracy theory, but impartially investigated by those with the responsibility and salary to do so. While running the charity CO-Gas Safety, I have found that one of the hardest things to do is raise concerns about any problems in an industry or profession.

Seaview, Isle of Wight, UK

Snooze alarm

From Angus Stevenson

I notice that the *New Scientist* book *Question Everything* is being promoted with the question “Why doesn’t your own snoring wake you up?” I can assure you from personal experience that my own snoring can wake me up.

Lerwick, Shetland, UK

The editor replies:

■ It can happen. But you can also wake when you stop snoring due to sleep apnoea, which can require medical investigation.

Management-speak

From Colum Clarke

Neither the authors of *Fuckology: Critical essays on John Money’s diagnostic concepts* nor your reviewer Simon Ings (13 December 2014, p 48) could be aware that the word “fuckology” was used and possibly coined by John Sorohan, director general of RTÉ, Ireland’s public service radio and TV broadcaster, in the late 1980s.

He had come up through the engineering ranks and was, therefore, a fairly straight thinker.

He was of course referring to management-speak, faffing around and in general not sticking

to the point. His catchphrase was “we’ll have no fuckology around here”.

Kilmacanoge, Co. Wicklow, Ireland

Librarians rule

From Jill Ratzan

As a librarian and information scientist – and one continually being told how “obsolete” my field is becoming – I was gratified



to read Laura Dattaro’s article on the importance of data scientists (US edition, 6 December 2014, p 52. See bit.ly/EWDData).

Dattaro is correct in saying that cataloguing and classification are essential to large data sets, and that librarians are essential parts of science teams. We have indeed, as Nancy Ritchey is quoted as saying, been in the business of making information available and searchable for centuries.

Highland Park, New Jersey, US

Black diamonds

From Bryn Glover

Guy Cox says it is irresponsible to burn precious resources (20/27 December 2014, p 42). At a seminar in the late 1970s, Arthur Scargill, then leader of the UK’s National Union of Mineworkers, spent some time describing the range of uses to which coal can be put. He concluded that the very worst thing we can do is throw it on a hearth and set fire to it.

Glasshouses, North Yorkshire, UK

Shedding the pounds

From Jane Kent

Am I missing something in Michael Blumlein’s short story “Y(ou)r q(ua)ntifi(e)d s(el)f” (20/27 December 2014, p 80)? Or can I reset my scales to kilograms and lose 1 kilogram of weight more quickly than I can lose half a pound? This sounds to me like a great New Year weight loss plan.

Brecon, Powys, UK

The editor writes:

■ We were expecting a subtle joke there. But it was just wrong.

Eyes in the sky

From Ed Gauss

Thank you for the image of comet 67P/Churyumov-Gerasimenko (13 December 2014, p 12). And, hey, I immediately saw this face...

Niwot, Colorado, US

For the record

■ The illustration accompanying our story on deep-sea life was a little murky: bottom-dwelling amphipods are shrimp-like, but not shrimp (6 December 2014, p 46)

■ Our article on educational robots (6 December 2014, p 22) loses marks: Nanyang Technology University is actually in Singapore.

■ And Martin Bojowald is at Penn State University’s University Park campus (13 December 2014, p 34).

■ We should have spelled the name of vice-admiral Robert FitzRoy, promoter of the storm glass, as he did – with what would now be called an InterCap (20/27 December 2014, p 68).

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READER Bernard Morcheles sends his tip for losing weight. He stresses that “this is not a diet” and we leave you to imagine the emphatic typography. His secret is simple: “Don’t put anything in your mouth larger than the size of the first joint of your thumb; chew everything completely before swallowing; and don’t put anything else in your mouth until you have swallowed.” Ah, yes, that would be “mindful eating”.

Feedback went looking for quotes from our very, very old friend, the Zen teacher Thich Nhat Hanh, to see what he had to say about this aspect of mindfulness. We discovered that he has a whole book out, *Savor: Mindful Eating, Mindful Life*, with Harvard public health lecturer Lilian Cheung.

But... you must want mindfulness (at the same time as letting go of attachment to wants, natch). Hence research on mindless eating – on tricks we can play once on ourselves that keep on working, such as using different cutlery and plates – as reported, felicitously, on page 36.

SNARKS. Feedback demanded, modestly, that theorists come up with a particle of this name (8 November 2014). Readers reminded us that anyone on the brink of observing such a thing would “softly and suddenly vanish away” as Lewis Carroll wrote in the *Hunting of the Snark* (20/27 December 2014).

Now a colleague informs us that physicists have, contrary to Carroll’s rule, observed a boojum. Richard Webb, lamenting the fading-away of whimsical names for newly described objects of scientific enquiry, recorded that a geometrical pattern sometimes seen on the surface of superfluid helium-3 is called a boojum (*New Scientist*, 20 December 2008, p 63). In fact, the isotope’s alternative configuration, the “yozh”, is chased away by the appearance of a boojum.

A full account of how David Mermin “decided to make the word ‘boojum’ an internationally

accepted scientific term” is at bit.ly/BoojumStory. Now: who has sighted a snark, and lived to tell the tale?

INNOCENTLY, Feedback enquired why it was that people are sensitive about images of their car’s number plate being reproduced online (29 November 2014). Several readers were happy to explain. Their information is of course devoted to logical completeness only, as was our query.

Angus Stevenson suggests that having spent a great deal on a cherished number, “some owners belatedly discover that it is a great identifier and its removal is perhaps down to being caught in a possibly compromising position”. We leave the rest to your imagination.

Steve Shrewsbury adds that the UK plate “UFO 1” and its numeric successors may be an example of this. In trying to discover to what or whom he may refer, Feedback encountered an entire subculture whose existence should have, but had not, occurred to us: number-plate spotters.

THE above suggestions about identification by number plates have enough of the flavour of schadenfreude to suggest that caution about them is, on the face of it, required. But the scenario that Robert Trybis suggests has the authentic ring of truthiness.

Imagine yourself, for a moment, to be crooked. Find online an image of a car that matches yours in make, model and colour. Obtain plates, perhaps from a crooked friend, bearing the number of that car. Fix them to yours. Proceed to collect speeding and parking fines – and penalties for non-payment of the daily “congestion charge” applied to vehicles entering central London. Observe the penalty notices not arriving, because they’re going to the owner of the car whose plates you cloned.

Now stop imagining. NOW.

ALSO, we asked about spottings of plates with interesting patterns (29 November 2014). Brian King

suggests that “SSS 999” contains two palindromes even when inverted, but does not claim to have spotted it. We find a report of it being auctioned with a reserve price of £1900.

Keith Clement may have come up with a richer seam, having observed “HNO3 RNA”. What ribonucleic acid nitrate would be, other than a smelly mess, we’re not sure. But there must be more chemical formulae out there.

FINALLY – perhaps ultimately – a colleague makes an alarming observation. They were idly searching for background on the question of artificial intelligences deciding they could supersede humans’ messy wetware mind implementation.

They came across this announcement: “*International Journal of Machine Consciousness* has ceased publication. The last issue published was Volume 6 Issue 2 (2014).” The colleague



“can presume only that the machines took over and decided the less we know, the better...”

They can’t be that good, though, if they can’t hide the news of their takeover from a famous web search engine with ambitions to be one of them.

Just in case, Feedback wants it on the record that we welcome our new AI overlords.

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week’s and past Feedbacks can be seen on our website.

It’s not an urban legend. Rick McCarty sends a photo of a cafe/filling station near Vail, Colorado, exhorting “eat here, get gas”. But is it a deliberate bid for Feedback fame?

Shell suits

I found this egg among my groceries (see photo, below). It has a strongly ridged shell with the pattern of ridges resembling veins or arteries, while the surface between the ridges is densely pitted with a few isolated, tiny, pimple-like protrusions. The deformities are more prominent on the narrower end of the egg. What is the explanation, and is such an egg safe or palatable to eat? I did not feel inclined to put this to the test.



■ The most likely cause of the deformity is an interruption to the part of egg formation called the plumping process.

An egg begins to form when the ovum (the yolk) is released from the hen's ovary. It is then picked up by the infundibulum and proceeds on down through the reproductive tract, picking up

albumen (the white) as it goes.

After the shell membrane is added, a process called plumping occurs in which fluids pass through the membrane, causing the white to swell and fill the

"If something goes wrong with the timing, the shell may harden before the egg is completed"

space within the membrane. Once full, the shell hardens.

If something goes wrong with the timing of this process, the shell may harden before it is completed. In that case, you get an egg which may be misshapen in the way the photograph shows.

It is surprising, however, that such an oddly shaped egg reached the consumer market because they are usually rejected during the grading process.

*Kim Critchley
Clarence Park, South Australia*

This week's questions

SHALL WE PRESS ON?

When using a French press with a wire mesh filter to make a batch of coffee, the force required to move the plunger down seems constant until just near the end. For the last few centimetres, as the slurry of suspended ground coffee becomes denser, the force required dramatically drops. Why is this?

*Christopher Gilfillan
Surrey Hills, Victoria, Australia*

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SABRE-TOOTHED SQUIRREL

This squirrel (see photo, above) appeared in a local garden during the recent fine weather. Can anyone explain the strange white appendages on its face? *Geoff Thomas
Merthyr Tydfil, Mid Glamorgan, UK*

GIMME THE PLANE TRUTH

I have often been told that plane trees in London can cope with the high levels of pollution in the city because they draw it into

"Small or large bubbles could be the same colour and this didn't change wherever they drifted"

their bark, which they then shed. Is there any truth in this? *Mike Griffiths
Croydon, Surrey, UK*

TOIL AND BUBBLE...

My daughter was blowing bubbles from a pot she bought from a toyshop. We were surprised to see that the bubbles varied in colour. Some were blue, some green, some red or pink or orange. And sometimes the outer skin of the bubble appeared to be one colour and the inside another.

At first we thought it must be caused by their size or their angle to the sun. But it wasn't. Small or large bubbles could be the same colour, and the colour remained the same wherever the bubbles drifted. Different colours would come from a single blow of the soap substance used to create them. So we decided it must be down to the chemistry of the soap. Can anybody explain further?

*Keith and Joanna Hamley
Hastings, Sussex, UK*

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